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STAGE II COMPARABILITY STUDY FOR THE NORTHEAST OZONE TRANSPORT REGION

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Air Quality Strategies and Standards Division

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NOTICE OF ERROR IN EARLIER PRINTING

After distribution of the first printing of this document, it was discovered that there were errors in Tables 5-2, 5-4, and 5-5. In calculating the comparable VOC reductions in these tables, the NOx reductions were inadvertently multiplied by, rather than divided by, the NOx ratios. These errors have been corrected in this printing. In addition, the text which summarizes the data in Section 5.2 (page 45), Section 5.3.3 (page 51), Section 5.4.2 (page 57) and Section 5.4.3 (page 57) has been revised to reflect the corrected tables.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

ACRONYMS AND ABBREVIATIONS

Act	1990 Clean Air Act
AF	air-to-fuel (ratio)
BACT	best available control technology
BEA	Bureau of Economic Analysis
BOOS	burners out of service
CMSA	consolidated metropolitan statistical area
CO	carbon monoxide
CTG	control techniques guideline
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ERCAM	emission reduction and cost analysis model
FGR	fuel-gas reburning
FIP	Federal implementation plan
HPMS	highway performance monitoring system
I/M	inspection and maintenance
IC	internal combustion
IR	ignition timing retardation
ISBM	independent small business marketer
L-E	low emission
LDAR	leak detection and repair
LDGT	light-duty gasoline truck
LDGV	light-duty gasoline vehicle
LEA	low excess air
LEV	low emission vehicle
LNB	low-NO_x burner
MSA	metropolitan statistical area
NAAQS	national ambient air quality standard
NAPAP	national acid precipitation assessment program
NGR	natural gas reburning
NO_x	nitrogen oxides
NSCR	non-selective catalytic reduction
NSPS	new source performance standard
OFA	overfire air
OMS	Office of Mobile Sources
ORVR	onboard refueling vapor recovery
OTR	Northeast Ozone Transport Region
PC	pulverized coal
RACT	reasonably available control technology
ROM	Regional oxidant model
RVP	Reid vapor pressure
SCR	selective catalytic reduction
SEDS	State energy data system
SIP	State implementation plan
SNCR	selective non catalytic reduction
SOCMI	synthetic organic chemical manufacturing industry
TCM	transportation control measure
tpd	tons per day
tpy	tons per year

ACRONYMS AND ABBREVIATIONS (continued)

ULNB	ultra-low NO_x burner
VMT	vehicle miles traveled
VOC	volatile organic compound

PREFACE

In order to address the problem of interstate ozone air pollution in the Northeast, section 184 of the Clean Air Act of 1990 (Act) established the Ozone Transport Region (OTR). The OTR is comprised of 12 Northeastern States and the District of Columbia. An Ozone Transport Commission (OTC) was also established, composed of representatives of the 13 OTR jurisdictions and EPA, to coordinate ozone control efforts in the OTR. The section 184 provisions contain additional control requirements which apply throughout the OTR, even in ozone attainment areas. One of these is the 184(b)(2) requirement for Stage II vapor recovery (Stage II) or comparable measures. Stage II control devices at gasoline pumps capture volatile organic compounds (VOC) emissions from vehicle refueling.

Since passage of the Act, EPA has been working with the OTC member States to evaluate the ozone problem in the OTR through the use of the Regional Oxidant Model. The modeling results indicate that, beyond the basic VOC control programs, additional nitrogen oxides (NOx) reductions appear to be more effective than VOC controls, particularly in attainment areas, in helping control ozone levels in downwind nonattainment areas. Based on these findings, the OTC has been focusing its efforts on developing regional NOx control strategies.

For example, on September 27, 1994, the OTC signed a Memorandum of Understanding (MOU) to control NOx emissions from power plants and other large fuel combustion sources. The NOx MOU will result in substantial NOx reductions throughout the OTR. In addition, on February 10, 1994, the OTC recommended that EPA require the low emission vehicle (LEV) program to reduce motor vehicle NOx and VOC emissions in the region. The EPA has recently taken final action to approve this petition. The OTC is continuing to investigate additional regional NOx control strategies.

Moreover, on January 24, 1994, EPA promulgated the onboard refueling vapor recovery (ORVR) rules (at 59 FR 16262, April 6, 1994) which require onboard refueling emissions controls on passenger cars and light-duty trucks. When fully phased in, the ORVR rule will control 95 percent of refueling emissions nationwide from these vehicles. Because onboard controls and Stage II target the same emissions source, the benefits of Stage II will steadily decrease as more and more vehicles with onboard controls enter the fleet. Ultimately, the Stage II program will become largely a redundant control effort. The authors of the Act recognized this and released moderate ozone nonattainment areas from the general Stage II requirement under section 182(b)(3) upon promulgation of the ORVR rule. See section 202(a)(6) of the Act. (However, inasmuch as it will take 10 to

15 years for onboard controls to be fully phased in, early emissions reductions from Stage II can be beneficial in reducing air toxics and States may want to implement it for this purpose.)

Considering the significant NOx reductions that the OTR States have committed to achieve through their regional NOx control strategies and that, in the long term, onboard controls will render Stage II largely redundant, EPA is concerned that emissions reductions from the section 184(b)(2) Stage II requirement for *regional* ozone purposes may not justify the cost, particularly in attainment areas. Therefore, EPA will immediately begin working with the OTC and affected States to determine how to best achieve the required ozone benefits in each affected area.

EXECUTIVE SUMMARY

This report was prepared in response to section 184(b)(2) of the 1990 Clean Air Act (Act) which requires the U.S. Environmental Protection Agency (EPA) to conduct a study to identify control measures capable of achieving emissions reductions comparable to those achievable by Stage II vehicle refueling controls in the Northeast Ozone Transport Region (OTR).

Ground-level Ozone

Ground-level ozone has been a pervasive pollution problem in the United States for several decades. In the upper atmosphere ozone occurs naturally and forms a protective layer to shield the earth from the sun's harmful ultraviolet rays. However, in the lower atmosphere, or at "ground level," man-made ozone can cause a variety of problems to human health, crops, and trees. Ground-level ozone is the focus of this report.

Ground-level ozone causes health problems because it damages lung tissue, reduces lung function, and sensitizes the lungs to other irritants. Scientific evidence indicates that ambient levels of ozone not only affect people with impaired respiratory systems, but healthy adults and children, as well. Each year ground-level ozone is also responsible for several billion dollars worth of agricultural crop yield loss. Studies also indicate that current ambient levels of ozone are responsible for damage to forests and ecosystems.

Ground-level ozone is particularly difficult to control because it is not emitted directly into the atmosphere, but instead is formed by a complex photochemical reaction caused primarily by volatile organic compounds (VOCs), nitrogen oxides (NO_x), heat, and sunlight. The VOCs are emitted from a variety of sources, including industrial and chemical processes, and automobile refueling, among others. The NO_x is emitted from the combustion of fuels from sources such as automobiles, power plants, and industrial boilers.

One of the major VOC control programs that has been implemented by many States is controls at gasoline stations to capture emissions that occur during automobile refueling. These programs are known as Stage II vapor refueling controls (Stage II).

Historically, there has been a major ozone nonattainment problem in the Northeastern United States. Much of the problem is due to regional transport of ozone and ozone precursors (VOC and NO_x). To address this problem of interstate ozone air pollution, section 184(a) of the Act specifically created the

OTR, which is comprised of 12 Northeastern States and the District of Columbia. Because of concern about the emissions from attainment areas contributing to violations of the ozone standard in downwind areas, the Act also requires the OTR States to adopt Stage II or a comparable measure in attainment areas, as well as nonattainment areas.

Stage II Comparability Study

The section 184(b)(2) requirement to adopt Stage II or a comparable measure applies to all attainment and nonattainment areas in the OTR. However, because States must adopt Stage II in serious and severe nonattainment areas under a separate requirement under section 182(b)(3), only moderate and below nonattainment areas and attainment areas may take advantage of the flexibility provided in the section 184(b)(2) provision to adopt a comparable measure instead of Stage II. For this reason, emissions reductions estimates for various control measures are only provided for moderate and below nonattainment areas and attainment portions in the OTR. Because the OTR States of Connecticut, Massachusetts, and Rhode Island, and the District of Columbia consolidated metropolitan statistical area (CMSA) are comprised solely of serious and severe areas, they must adopt Stage II statewide. Therefore, these States and the District of Columbia CMSA are not included in this study.

Only measures not already prescribed in the Act may be considered as potential comparable measures. Under EPA's interpretation of section 184(b)(2), such prescribed measures or measures already required under the State's implementation plan prior to 1990 may not be substituted for Stage II. For example, onboard refueling vapor recovery controls cannot be considered as a comparable measure because they are required of all areas by a Federal rule. However, control measures that are used to meet rate-of-progress requirements or to reach attainment, but are not otherwise required by the Act, may be used to meet the section 184(b)(2) requirement.

The emissions reductions estimates for Stage II and alternative measures are given for future year 1999. This year corresponds to the attainment date for serious ozone areas. This year was selected as the timeframe for comparability because it is the first statutory attainment date and milestone year that would occur following full phase-in of a Stage II program, if a State chose to adopt Stage II rather than a comparable measure. The Act provides for a 2-year phase-in schedule for Stage II, with an optional third year to phase-in independent small business marketers.

To provide flexibility to the States, this report does not specify a list of comparable measures from which each area must select. Rather, emission reduction estimates are provided for a variety of measures that a State can examine for a strategy comparable to Stage II. The emission reduction estimates for the alternative measures are given for nonattainment and attainment areas on an area-by-area basis. A State may select comparable measures for each individual affected area or may determine comparability on an aggregate basis for affected areas in the State.

Some alternative measures may not be comparable alone, but in combination with other measures may achieve comparable emissions reductions to Stage II. The State may choose to adopt a single measure or a number of control measures whose emissions reductions equal or exceed Stage II reductions. As single measures, reformulated gasoline, enhanced inspection and maintenance programs (in areas where they are not already required), and more stringent stationary source NO_x controls show comparability for a number of areas. (States should be aware that there are significant legal and technical issues regarding whether and how reformulated gasoline programs can be applied in attainment areas and nonclassifiable nonattainment areas. The EPA is currently exploring these issues.)

States may substitute NO_x emissions reductions for VOC reductions according to the methodology given in this document. If a particular measure provides both VOC and NO_x reductions, these may be added together to yield a total emissions reduction estimate for the measure.

States have the option of conducting an independent comparability analysis to re-examine measures covered in this report using up-to-date, State-specific information or to evaluate control measures not included in this report.

Within one year of completion of the study, States must adopt and submit as a State implementation plan (SIP) revision either Stage II or a comparable measure. States are encouraged to rely on the information presented in this study report as guidance in determining which measures may be considered comparable to Stage II for their areas. The EPA believes this is what Congress intended by requiring EPA to issue this study. However, because this study report did not go through notice-and-comment rulemaking, it is not EPA's final action on the question of which measures are comparable to Stage II. The EPA will entertain comments on the study findings for a specific area in the context of rulemaking on a SIP submittal intended to satisfy the Act requirement for Stage II or a comparable measure.

1.0 INTRODUCTION

This document was prepared in response to section 184(b)(2) of the 1990 Clean Air Act (Act) which requires the U.S. Environmental Protection Agency (EPA) to conduct a study to identify control measures capable of achieving emissions reductions comparable to those achievable by Stage II vehicle refueling controls (Stage II) in the Northeast Ozone Transport Region (OTR).

1.1 Ground-level Ozone

Ground-level ozone has been a pervasive pollution problem in the United States for several decades. In the upper atmosphere, or stratosphere, ozone occurs naturally and forms a protective layer to shield the earth from the sun's harmful ultraviolet rays. However, in the lower atmosphere, or at "ground level," man-made ozone can cause a variety of problems to human health, crops, and trees.

Ground-level ozone causes health problems because it damages lung tissue, reduces lung function, and sensitizes the lungs to other irritants. Scientific evidence indicates that ambient levels of ozone not only affect people with impaired respiratory systems, such as asthmatics, but healthy adults and children, as well. Exposure to ozone for six to seven hours at relatively low concentrations has been found to significantly reduce lung function in normal, healthy people during periods of moderate exercise. This decrease in lung function is often accompanied by such symptoms as chest pain, coughing, nausea, and pulmonary congestion.

Though not as well established in humans, animal studies have demonstrated that repeated exposure to ozone for many months can produce permanent structural damage in the lungs and accelerate the rate of lung function loss, as well as the aging of lungs. Each year ground-level ozone is also responsible for several billion dollars worth of agricultural crop yield loss. It also causes noticeable foliar damage in many crops and species of trees. Studies also indicate that current ambient levels of ozone are responsible for damage to forests and ecosystems.

Ground-level ozone is particularly difficult to control because it is not emitted directly into the atmosphere, but instead is formed by a complex photochemical reaction caused primarily by volatile organic compounds (VOCs), nitrogen oxides (NO_x), heat, and sunlight. The VOCs are emitted from a variety of sources, including automobile exhaust, industrial and chemical processes, evaporating gasoline vapors, and automobile refueling, among others. The NO_x is emitted from the combustion of fuels from sources such as automobiles, power plants, and industrial boilers.

One of the major VOC control programs that has been implemented by many States is Stage II controls at gasoline stations to capture emissions that occur during automobile refueling. (Controls put into place to capture VOC emissions that occur earlier in the gasoline marketing chain, during loading/unloading gasoline from bulk terminals, are known as Stage I controls.)

By 1990, there were 98 areas in the country that did not meet the EPA-established national ambient air quality standard for ozone. About 140 million Americans lived in these areas. Many of these areas were in the Northeastern United States. That same year the U.S. Congress passed new amendments to the Clean Air Act. The amended Act requires a broad array of programs to further reduce emissions of VOCs, NO_x, and other pollutants from the automobile, petroleum, chemical, steel, utility, and pulp and paper industries, as well as a wide variety of other large and small sources.

1.2 Clean Air Act Requirements

Historically, there has been a major ozone nonattainment problem in the Northeastern United States. Much of the problem is due to regional transport of ozone and ozone precursors (VOC and NO_x). To address this problem of interstate ozone air pollution, section 184(a) of the Act specifically created the OTR, which is comprised of the entire States of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont, and the District of Columbia consolidated metropolitan statistical area (CMSA), which includes a portion of Virginia.

Figure 1-1 provides a map of the OTR showing the designated attainment and nonattainment areas. The Act established five classifications of ozone nonattainment areas. In ascending order of severity of the air pollution problem, these are: marginal, moderate, serious, severe, and extreme. In addition, there are three types of nonclassifiable ozone nonattainment areas: submarginal, transitional, and incomplete/no data. (See Appendix A for the definitions of the ozone nonattainment area types.) The OTR ozone areas are listed by classification in Table 1-1. Within the OTR, there are no extreme, submarginal, or transitional areas.

The Act requires specific control requirements according to the designation and classification of each area. Section 184 also provides for a specific set of additional requirements for the OTR designed to address the regional transport problem.

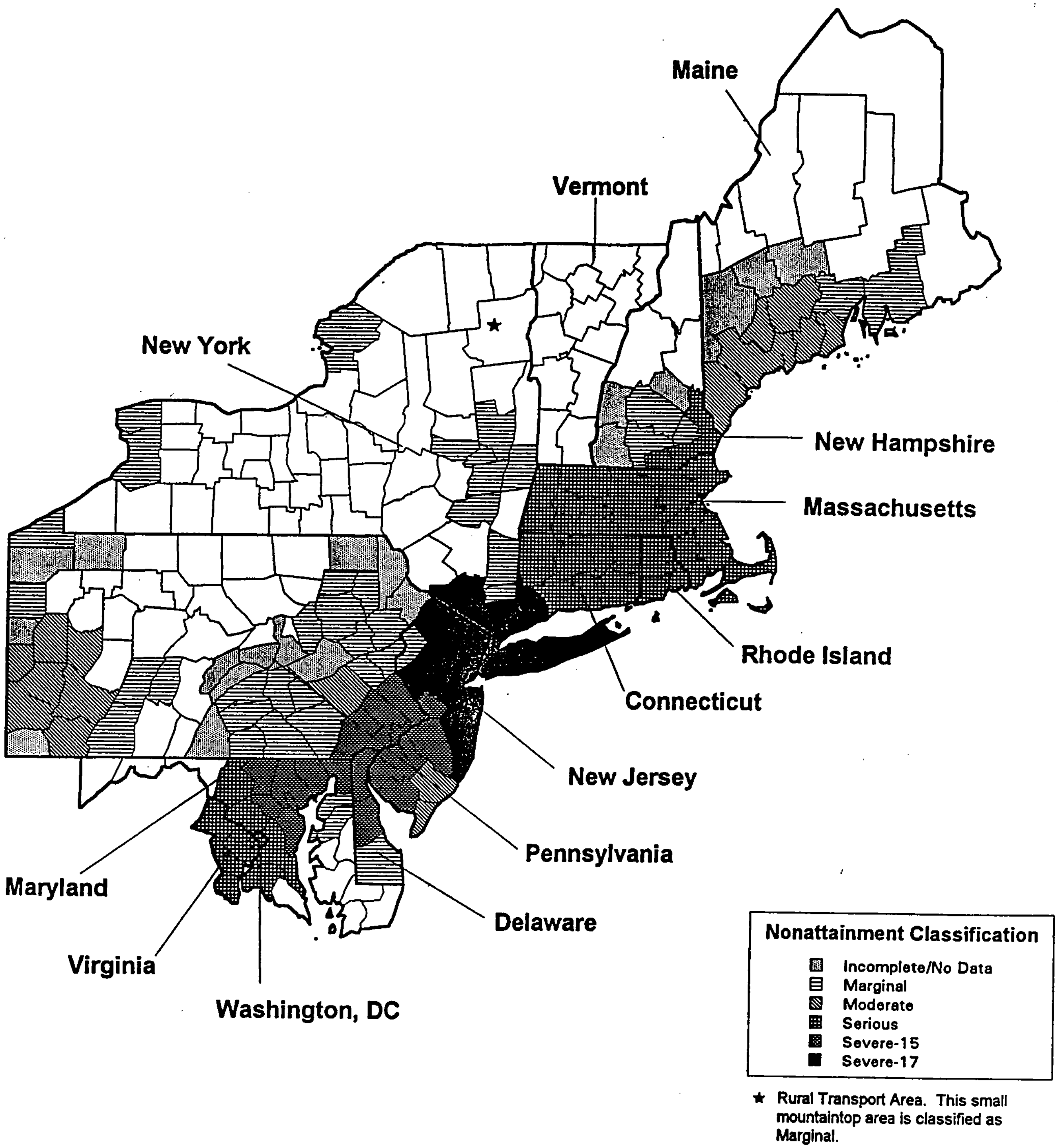

Figure 1-1 Northeast Ozone Transport Region Ozone Nonattainment Areas

Table 1-1. Ozone Nonattainment Areas in the Ozone Transport Region

Severe-17	
New York-N New Jer-Long Is, NY-NJ-CT	
Severe-15	
Baltimore, MD	Philadelphia-Wilm-Trent, PA-NJ-DE-MD
Serious	
Boston-Lawrence-Worcester (E.MA), MA-NH	Providence (All RI), RI
Greater Connecticut	Springfield (Western MA), MA
Portsmouth-Dover-Rochester, NH	Washington, DC-MD-VA
Moderate	
Atlantic City, NJ	Portland, ME
Knox & Lincoln Cos, ME	Poughkeepsie, NY
Lewiston-Auburn, ME	Reading, PA
Pittsburgh-Beaver Valley, PA	
Marginal	
Albany-Schenectady-Troy, NY	Johnstown, PA
Allentown-Bethlehem-Easton, PA-NJ	Kent and Queen Anne's Cos, MD
Altoona, PA	Lancaster, PA
Buffalo-Niagara Falls, NY	Manchester, NH
Erie, PA	Scranton-Wilkes-Barre, PA
Essex Co (Whiteface Mtn), NY	Sussex Co, DE
Hancock & Waldo Cos, ME	York, PA
Harrisburg-Lebanon-Carlisle, PA	Youngstown-Warren-Sharon, OH-PA*
Jefferson Co, NY	
Incomplete/No Data	
Franklin Co (part), ME	Juniata Co, PA
Oxford Co (part), ME	Lawrence Co, PA
Somerset Co (part), ME	Northumberland Co, PA
Belknap Co, NH	Pike Co, PA
Cheshire Co, NH	Schuylkill Co, PA
Sullivan Co, NH	Snyder Co, PA
Crawford Co, PA	Susquehanna, Co, PA
Franklin Co, PA	Warren Co, PA
Greene Co, PA	Wayne Co, PA

*Only the Pennsylvania counties of this nonattainment area are in the OTR.

These additional requirements include control measures for attainment areas as well as nonattainment areas.

For the OTR, there are two requirements related to Stage II vehicle refueling controls. One is the section 182(b)(3)requirement that all moderate and above nonattainment areas must adopt Stage II vehicle refueling controls. However, pursuant to section 202(a)(6), moderate areas were released from this requirement when EPA promulgated onboard vapor recovery rules. (See reference 1.)

The second is the section 184(b)(2) requirement that all areas in the OTR must adopt Stage II or alternative measures capable of achieving comparable emissions reductions, as identified in this study. Because States that contain serious and above nonattainment areas must implement Stage II programs under the first requirement above, even after promulgation of the onboard regulations, they cannot take advantage of the flexibility provided by section 184(b)(2) to adopt a comparable measure instead. Therefore, this document only evaluates alternative measures for moderate and below nonattainment areas and attainment portions of the OTR. Affected States have within 1 year of the completion of this study to adopt and submit as a State implementation plan (SIP) revision either Stage II or a comparable measure.

Section 182(b)(3) of the Act sets forth the general requirements for Stage II gasoline vapor recovery programs as follows:

> (3) GASOLINE VAPOR RECOVERY.
>
> (A) GENERAL RULE - Not later than 2 years after the date of the enactment of the Clean Air Act Amendments of 1990, the State shall submit a revision to the applicable implementation plan to require all owners or operators of gasoline dispensing systems to install and operate, by the date prescribed under subparagraph (B), a system for gasoline vapor recovery of emissions from the fueling of motor vehicles. The Administrator shall issue guidance as appropriate as to the effectiveness of such system. This subparagraph shall apply only to facilities which sell more than 10,000 gallons of gasoline per month (50,000 gallons per month in the case of an independent small business marketer of gasoline as defined in section 324).
>
> (B) EFFECTIVE DATE - The date required under subparagraph (A) shall be -
>
> (i) 6 months after the adoption date, in the case of gasoline dispensing facilities for which construction commenced after the date of the enactment of the Clean Air Act Amendments of 1990;

(ii) one year after the adoption date, in the case of gasoline dispensing facilities which dispense at least 100,000 gallons of gasoline per month, based on average monthly sales for the 2-year period before the adoption date; or

(iii) 2 years after the adoption date, in the case of all other gasoline dispensing facilities.

Any gasoline dispensing facility described under both clause (i) and clause (ii) shall meet the requirements of clause (i).

(C) REFERENCE TO TERMS - For purposes of this paragraph, any reference to the term "adoption date" shall be considered a reference to the date of adoption by the State of requirements for the installation and operation of a system for gasoline vapor recovery of emissions from the fueling of motor vehicles.

Section 182(b)(3)(A) requires Stage II vapor recovery on all gasoline dispensing facilities that dispense more than 10,000 gallons of gasoline per month or 50,000 gallons of gasoline per month for independent small business marketers (ISBM's).

In addition to the 2-year phase-in schedule of section 182(b)(3)(B), States can also opt for a 3-year phase-in period for ISBM's.

1.3 Study Approach

The major objectives of this study are to:

- assess the emission reductions associated with the implementation of Stage II vapor recovery in the study areas, and
- analyze the emission reductions associated with alternative control measures that may be selected as a control strategy comparable to Stage II.

A secondary objective is to examine the costs of the control measures analyzed to assist the States in their decisions of whether to adopt Stage II or comparable measures.

The Emission Reduction and Cost Analysis Model for VOC (ERCAM-VOC) was selected as the primary modeling tool in the study analysis. This model was used throughout the debate leading to the passage of the 1990 Clean Air Act Amendments to analyze the costs and emission reductions associated with the alternative measures aimed at controlling VOC.

The ERCAM-VOC was created to analyze the national impacts of VOC controls; thus, many of the modeling techniques reflect the needs for analyzing this large domain. Since the study only addresses certain areas in the OTR, improvements in the modeling methods were implemented for the Stage II and motor vehicle components of the model. State-specific emission factor (MOBILE5a) modeling was performed for these sectors. The specific modeling techniques are discussed in more detail in Chapters 3 and 4 of this report.

The EPA promulgated regulations for onboard vapor recovery on January 24, 1994. In recognition of this, the Stage II emission reduction benefit analysis assumes onboard vapor recovery rules are promulgated in 1994 with a phase-in of onboard controls beginning in model year 1998.

The base year emissions for the study area are from the Interim 1990 Inventory. This data source was chosen because it covers the entire geographical region studied under this analysis. While SIP emissions inventory data may be available for some areas, States are required to submit 1990 emission inventories only for their nonattainment areas (data may also be available for surrounding counties for modeling purposes) and the inventories are not currently finalized. It is acknowledged that State-submitted data may differ from the inventory data used in this analysis.

The Interim Inventory point source emissions are projected from the 1985 National Acid Precipitation Assessment Program (NAPAP) Inventory. State point source inventories are expected to be higher because the 1985 NAPAP Point Source Inventory generally did not include sources in the 25 to 100 ton per year range. However, the inventory may contain sources of nitrogen oxides (NO_x) within this size range if the source is a major emitter of another criteria pollutant. While the effects of applying reasonably available control technology (RACT) to sources at this level are examined in this report, the effects are expected to be underestimated due to the limitations of the inventory.

Control measures were selected for analysis based on the availability of data on control effectiveness, coverage of emissions in the inventory, effectiveness in less urbanized areas, and availability of modeling approaches for assessing the emission reductions. Only measures not already prescribed in the Act were considered because, under EPA's interpretation of section 184(b)(2), such prescribed measures and measures already required under the State's implementation plan prior to 1990 may not be substituted for Stage II. Control measures that are used to meet rate-of-progress requirements or to reach attainment, but are not otherwise required by the Act, may be used to meet the section 184(b)(2) requirement.

Initially, a comprehensive list of alternative control measures was developed and each was examined with respect to the criteria above. The list was then narrowed, based on the criteria discussed above, to include the following measures:

- enhanced inspection and maintenance (I/M),
- reformulated gasoline program,
- more stringent control on existing VOC stationary sources,
- RACT to 25 tpy NO_x stationary sources, and
- more stringent control of existing NO_x stationary sources.

These control measures are evaluated in Chapters 4 and 5. States also have the option to evaluate other control measures.

1.4 Organization of Report

The information in this report provides the basis for State selection and adoption of control measures comparable to Stage II.

Chapter 2 discusses how the information presented in this report is to be used by States in making a comparability determination.

Chapter 3 discusses the methods used to model Stage II emission reductions and presents the emissions reductions estimates on an area-by-area basis.

Chapter 4 evaluates mobile and stationary VOC control measures as potential comparable measures. The modeling assumptions used for each control measure are described.

Chapter 5 evaluates mobile and stationary source NO_x control measures as potential comparable measures. The chapter provides a NO_x substitution method for determining what level of NO_x emissions reductions is comparable to the VOC emissions reductions from Stage II.

Chapter 6 describes a method by which States can conduct an independent comparability analysis to re-examine measures covered in this report using up-to-date, State-specific information or to evaluate control measures not included in the report.

2.0 COMPARABILITY DETERMINATIONS

2.1 Applicability

The section 184(b)(2) requirement to adopt Stage II or a comparable measure applies to all attainment and nonattainment areas in the OTR. However, because States must adopt Stage II in serious and severe nonattainment areas under a separate requirement under section 182(b)(3), only moderate and below nonattainment areas and attainment areas may take advantage of the flexibility provided in the section 184(b)(2) provision to adopt a comparable measure instead of Stage II. For this reason, emissions reductions estimates for various control measures are only provided for moderate and below nonattainment areas and attainment portions in the OTR. Because the OTR States of Connecticut, Massachusetts, and Rhode Island, and the District of Columbia CMSA are comprised solely of serious and severe areas, they must adopt Stage II statewide. Therefore, these States and the District of Columbia CMSA are not included in this study.

2.2 Time Frame for Comparability

In the following chapters, emissions reductions for Stage II and alternative measures are given for the future year 1999. This year corresponds to the attainment date for serious ozone areas. This year was selected because it is the first statutory attainment date that would occur following full phase-in of a Stage II program, if a State chose to adopt Stage II rather than a comparable measure. The Act provides for a 2-year phase-in schedule for Stage II, with an optional third year to phase-in ISBM's. For marginal and below nonattainment areas and attainment areas, the emissions reductions achieved from application of this requirement are clearly intended to assist in the attainment of downwind areas of higher classifications rather than for attainment in the controlled area. (Marginal areas were required to be in attainment by November 15, 1993.) For moderate areas, the emissions reductions may also help bring the local area into attainment.

2.3 Comparable Measure Selection

Only measures not already prescribed in the Act may be considered as potential comparable measures. Under EPA's interpretation of section 184(b)(2), such prescribed measures or measures already required under the State's implementation plan prior to 1990 may not be substituted for Stage II. For example, onboard refueling vapor recovery (ORVR) controls cannot be considered as a comparable measure because they are required of all areas by a Federal rule. However, control measures that are used to meet rate-of-progress requirements or to reach attainment, but are not otherwise required by the Act, may be used to meet the section 184(b)(2) requirement.

To provide flexibility to the States, this report does not specify a list of comparable measures from which each area must select. Rather, emission reduction and cost information are provided for a variety of measures that the State can examine for a strategy comparable to Stage II for a particular area. Stage II emissions reductions are contained in Chapter 3. These emissions reductions estimates establish the level of emissions reductions that an alternative control measure must achieve or exceed to be comparable. Emissions reductions estimates for alternative VOC and NO_x control measures are given in Chapters 4 and 5, respectively.

Some alternative measures may not be comparable alone, but in combination with other measures may achieve comparable emissions reductions to Stage II. The State may choose to adopt a single measure or a number of control measures whose emissions reductions equal or exceed Stage II reductions. In addition, States may substitute NO_x emissions reductions for VOC reductions according to the methodology given in Chapter 5.0. If a particular measure provides both VOC and NO_x reductions, these may be added together to yield a total emissions reduction estimate for the measure.

Emissions reduction estimates for the alternative VOC and NO_x control measures are given for nonattainment and attainment areas on an area-by-area basis. A State may select comparable measures for each individual affected area or may determine comparability on an aggregate basis for affected areas in the State. In the second case, if the sum of the projected emissions reductions from the selected alternative measure in applicable areas equals or exceeds the sum of the projected Stage II reductions for the same areas, the alternative measure would be considered comparable.

2.4 Conducting an Independent Comparability Analysis

States have the option of conducting an independent analysis to re-examine measures covered in this report using up-to-date, State-specific information or to evaluate control measures not included in this report. The methodology for the analysis is provided in Chapter 6.0.

3.0 STAGE II EMISSION REDUCTIONS

This chapter describes the emission projection methodology and modeling assumptions used to estimate VOC emission reductions from Stage II vapor recovery controls. Results of the modeling analyses are provided on an area-by-area basis for the year 1999. The emissions reductions estimated for Stage II establish the level of emissions reductions that an alternative control strategy must meet to be considered a comparable measure.

3.1 MODELING ASSUMPTIONS

3.1.1 Refueling Emissions

Base year vehicle refueling emissions are estimated from gasoline consumption (by county) and State-specific MOBILE5a emission factors. (See reference 2.) Gasoline consumption estimates are based on the Interim 1990 Inventory. (See reference 3.) The Interim Inventory gasoline consumption estimates were projected from the 1985 NAPAP Inventory (see reference 4) based on State-level historical estimates of motor vehicle gasoline consumption from the U.S. Department of Energy (DOE) State Energy Data System (SEDS). (See reference 5.) The emission estimates presented in this analysis parallel those in the Interim Inventory with the exception that State-specific emission factors, rather than a national average emission factor, were used to estimate emissions.

Vehicle refueling emission projections are calculated by applying growth factors to the gasoline consumption estimates and multiplying this by the State-specific MOBILE5a refueling emission factor (in grams per gallon) for the projection year. National projections of gasoline usage from the MOBILE4.1 Fuel Consumption Model (see reference 6) were used to estimate growth for each area. The national estimates of gasoline consumption and corresponding annual (compounded) growth rates are shown in Table 3-1.

Table 3-1. National Gasoline Consumption Projections

Projection Year	Gasoline Usage (million gallons)	Equivalent Annual Growth (% per year)
1990	94,585	-
1999	105,221	1.2 (1990-1999)

State-specific refueling emission factors are used to account for differences in temperature and gasoline Reid vapor pressure (RVP). Summer (ozone) season temperatures and RVPs were used to calculate ozone season daily emissions. Table 3-2 presents the minimum and maximum temperatures, as well as the 1990 RVP, the phase II RVP, and the projection year RVP used as model inputs for each State. For areas with a 9.0 phase II limit, the projection year RVP is the phase II RVP minus a 0.3 psi default compliance safety margin. For areas with a phase II limit of 7.8 psi, no safety margin is applied. This is in accordance with EPA's Office of Mobile Sources (OMS) guidance on the selection of RVPs for modeling purposes. (See reference 7.) The MOBILE5a emission factor accounts for refueling vapor displacement and spillage losses. Underground tank breathing losses were estimated using AP-42 emission factors. (See reference 8.) These calculations are consistent with the methodologies recommended in the mobile source inventory guidance.

Table 3-2. MOBILE5a Model Inputs
Summer Season Temperatures and RVPs

State	Minimum Temperature[a] (°F)	Maximum Temperature[a] (°F)	RVP (1990)[b]	RVP (Phase II Limit)[c]	RVP (Projection Year)
Delaware	64	84	8.4	9.0	8.7
Maine	55	76	8.3	9.0	8.7
Maryland	65	85	8.3	7.8	7.8
New Hampshire	54	80	8.3	9.0	8.7
New Jersey	62	82	8.4	9.0	8.7
New York	61	81	8.3	9.0	8.7
Pennsylvania	62	83	8.6	9.0	8.7
Vermont	56	78	8.3	9.0	8.7

SOURCES: [a]See reference 9.
[b]See reference 10.
[c]See reference 11.

3.1.2 Stage II Control Assumptions

The Act and the General Preamble for the Implementation of Title I of the Clean Air Act Amendments of 1990 (Title I General Preamble) (see reference 12) include the following specifications for Stage II vapor recovery programs:

- Stage II must be applied to facilities that sell more than 10,000 gallons of gasoline per month (50,000 gallons per month for ISBM's). States are not precluded from adopting lower source size cutoffs (section 182(b)(3)).

- States should prescribe the use of Stage II systems that are certified to achieve at least 95 percent control of VOCs and that are properly installed and operated (General Preamble).

For modeling purposes, the control program requirements should be translated into a control device efficiency, a rule penetration (fraction of sources affected), and rule effectiveness (to account for equipment malfunctions and noncompliance). These three variables are combined to form an overall effectiveness for Stage II, which is input to MOBILE5a.

Because the Title I General Preamble specifies that the systems should be tested or certified at 95 percent reduction of VOC (for properly installed and operated systems), a 95 percent control device efficiency was used for the modeling analysis.

The penetration rate depends on the size cutoffs implemented by the area. The national average percentage of consumption excluded at various size cutoffs and corresponding penetration rates are shown in Table 3-3. (See reference 13.)

Table 3-3. Stage II Penetration Rates

Exemption Scenario	Percentage of Consumption Excluded (%)	Penetration Rate (%)
< 2,000 gal/month	2.4	97.6
<10,000 gal/month	2.8	97.2
<10,000 gal/month & ISBM's < 50,000 gal/month	10.0	90.0

The consumption estimates in Table 3-3 are based on a study of metropolitan area service station size distributions. This represents the best survey information to date and was used to determine overall effectiveness of Stage II. However, size distribution varies from area to area, and rural areas may tend to have a greater population of ISBM's.

The Act-mandated cutoffs of 10,000 gallons per month for gasoline dispensing facilities, or 50,000 per month in the case of ISBM's, were used in the modeling, with a penetration rate of 90 percent. If States opt to establish programs with a single size cutoff of 10,000 gallons per month, this would increase the emissions reductions from Stage II.

Rule effectiveness discounts the control device efficiency to account for noncompliance, equipment malfunctions, improper installation and maintenance, and improper use of the equipment. Table 3-4 shows the in-use efficiency and corresponding rule effectiveness values at various inspection levels. (See reference 13.)

The certification efficiency is the control device efficiency standard that Stage II vapor recovery systems are required to achieve. This is the baseline for measuring rule effectiveness. The Stage II Technical Guidance Document (see reference 13) notes that these in-use efficiency calculations do not account for misinstallation of underground vapor piping. Nevertheless, this represents the best available data on Stage II rule effectiveness.

Table 3-4. Stage II Rule Effectiveness

Inspection Frequency	In-Use Efficiency (%)	Rule Effectiveness (%)
Certification	95	----
Semi-Annual	92	96.8
Annual	86	90.5
Minimal	62	65.3

The Enforcement Guidance for Stage II Vehicle Refueling Control Programs (see reference 14) sets minimal standards for compliance inspections at gasoline dispensing facilities. This guidance specifies that a minimum of one compliance inspection should be conducted at each facility every year. Therefore, this analysis assumed annual inspections and used the corresponding rule effectiveness value from Table 3-4. Combining the control device efficiency (95 percent), rule penetration (90 percent), and rule effectiveness (90.5 percent) yields an overall effectiveness of 77 percent for Stage II. This was input to the MOBILE5a model to estimate projection year emission factors.

The emission factor for breathing losses with Stage II controls was calculated as a 77 percent reduction from uncontrolled levels, or 0.23 lbs VOC per 1,000 gallons of fuel.

3.1.3 Onboard Refueling Vapor Recovery Control Assumptions

Section 202 of the Act requires implementation of ORVR systems beginning with the fourth *model year* after the rules are promulgated. The ORVR rules were promulgated on January 24, 1994; therefore, the controls are required to be installed beginning with model year 1998 vehicles.

The ORVR rules require ORVR systems to be installed on 40 percent of light-duty gasoline vehicles (LDGV) in 1998, 80 percent in 1999, and 100 percent thereafter. Because MOBILE5a does not model this type of phase-in for ORVR controls (MOBILE5a only accepts a start year of input and assumes that all new vehicles in that model year install ORVR controls), a start date of model year 1999 was assumed in this analysis for LDGV. The effect of modeling ORVR control requirements with full implementation in the second model year rather than as phased-in over 3 years will tend to slightly underestimate the benefits of ORVR controls in 1999. This is because the sum of 40 percent of model 1998 LDGVs and 80 percent of model year 1999 LDGVs is greater than 100 percent of the new model cars in 1999. Slightly underestimating the reductions from ORVR controls, in turn, will cause reductions from Stage II to be slightly overestimated.

The ORVR rules also require a similar phase-in for controls on light-duty gasoline trucks (LDGT) beginning in 2001 for vehicles with a gross weight rating of 0-6,000 lbs, and in 2004 for vehicles with a gross weight rating of 6,001-8,500. Because emission reductions from controls on these vehicles begin after 1999, they do not affect the Stage II comparability analyses. However, in the future, as more and more vehicles with ORVR controls enter the fleet, the benefits of Stage II (incremental to ORVR) will decrease.

MOBILE5a applies a 96 percent reduction (from uncontrolled levels) to the refueling emissions from cars with ORVR controls. ORVR controls do not reduce breathing losses.

Because ORVR controls are mandated by the Act for all areas, ORVR controls have been applied first in the modeling simulations and will be attributed with controlling the refueling emissions in cases where redundancy occurs.

3.2 MODELING RESULTS

The emission reductions attributable to Stage II vapor recovery were calculated for each area by comparing the projection year with the uncontrolled baseline. As discussed above, emission reductions from Stage II are estimated assuming ORVR controls are installed. The results are presented in Table 3-5 for projection year 1999.

In general, emission reductions from Stage II are highest in larger and/or more urbanized areas. Urban areas exhibit a higher population density and thus higher gasoline usage. This increases the baseline vehicle refueling emissions from which emission reductions are measured. In many States, the area designated "Attainment Counties" in Table 3-5 shows the highest emission reduction simply because this division encompasses more counties than the individual nonattainment areas.

3.3 COST EFFECTIVENESS

The Stage II Technical Guidance Document (see reference 13) provides cost-effectiveness estimates for Stage II at various size cutoffs. Annual inspections are assumed in deriving these cost effectiveness values, which is consistent with the requirements of the Act and the modeling assumptions used in this analysis. Cost effectiveness may vary from area to area depending on the distribution of service station sizes and single versus multiproduct dispensers. The cost-effectiveness values shown in Table 3-6 are based on a nationwide survey of service stations that were classified into model plants. The cost-effectiveness estimates assume an equal distribution between single and multiproduct dispensers. Costs per ton are higher for multiproduct than for single-product dispensers.

At the Act-mandated size cutoffs of 10,000 and 50,000 for non-ISBM's and ISBM's, respectively, the average cost effectiveness is estimated to be $930 per ton.

Table 3-5. Stage II Vapor Recovery VOC Emission Reductions Projection Year 1999

Ozone Area	Stage II Reduction (tpd)
Delaware	
Sussex County	0.58
Maine	
Hancock & Waldo Counties	0.23
Knox & Lincoln Counties	0.29
Lewiston-Auburn	1.14
Portland	2.11
Franklin County	0.13
Oxford County	0.22
Somerset County	0.18
Attainment Counties	1.44
Maryland	
Kent & Queen Anne's Counties	0.29
Attainment Counties	2.74
New Hampshire	
Manchester	2.13
Belknap County	0.25
Chesire County	0.17
Sullivan County	0.15
Attainment Counties	0.78
New Jersey	
Allentown-Bethlehem-Easton	0.78
Atlantic City	3.37
New York	
Albany-Schenectady-Troy	3.84
Buffalo-Niagara Falls	4.39
Essex County	0.14
Jefferson County	0.40
Poughkeepsie	0.99
Attainment Counties	15.32

Table 3-5 (continued)

Ozone Area	Stage II Reduction (tpd)
Pennsylvania	
Allentown-Bethlehem-Easton	2.12
Altoona	0.45
Erie	1.54
Harrisburg-Lebanon-Carlisle	3.18
Johnstown	0.88
Lancaster	1.19
Pittsburgh-Beaver Valley	10.95
Reading	1.16
Scranton-Wilkes-Barre	2.51
York	1.38
Youngstown-Warren-Sharon	0.49
Crawford County	0.34
Franklin County	0.35
Greene County	0.14
Juniata County	0.07
Lawrence County	0.53
Northumberland County	0.28
Pike County	0.08
Schuylkill County	0.36
Snyder County	0.08
Susquehanna County	0.16
Warren County	0.17
Wayne County	0.22
Attainment Counties	4.35
Vermont	
Attainment Counties	2.64

Table 3-6. Cost-Effectiveness of Stage II

Exemption Scenario	Cost-Effectiveness ($/ton)
No exemptions	1,230
< 2,000 gal/month	1,130
< 10,000 gal/month	1,000
< 10,000 gal/month & ISBM's < 50,000 gal/month	930

SOURCE: See reference 13.

4.0 CONTROL MEASURES FOR VOLATILE ORGANIC COMPOUNDS

This chapter presents the results of the analysis of a variety of VOC control measures. Section 4.1 examines motor vehicle control measures and Section 4.2 examines stationary source measures. Emission reduction estimates provided for these measures should be compared with the emission reduction estimates for Stage II in Chapter 3.0 to determine whether a measure or combination of measures achieves comparable reductions to Stage II. Some of the measures also reduce NO_x emissions (see Chapter 5). In determining comparability to Stage II emissions reductions, the VOC and NO_x emissions reductions from an alternative measure may be combined according to the methodology provided in Section 6.1.

4.1 MOTOR VEHICLE MEASURES

The motor vehicle measures analyzed in the study that provide VOC emission reductions are: (1) enhanced I/M programs and (2) reformulated gasoline. Some areas (metropolitan statistical areas (MSA's) of 100,000 population or greater) are already required by the Act to implement enhanced I/M. For these areas, enhanced I/M cannot be considered as a comparable measure.

The following measures were considered but not included in the final study:

- Clean fuel fleets were evaluated in a preliminary scoping study and the resulting emission benefits were low. Programs targeting vehicle fleets show higher benefits in more urban areas. The affected areas in this study, in large part, are the less urbanized portions of the States. This measure was therefore not examined in the final study.

- Transportation control measures (TCM's) are also not included in the analysis. TCM's are, by nature, area specific and usually developed as a package of measures. It is beyond the scope of this study to develop potential TCM programs for each area. In addition, TCM's are generally most effective in urbanized areas. States wishing to consider TCM's instead of Stage II may conduct an independent analysis of the measures using the procedures provided in Chapter 6.

- The California low emission vehicle (LEV) program is also not included in this study. On February 10, 1994, the OTC submitted a recommendation to EPA that EPA require the LEV program throughout the OTR. Under this recommendation, the LEV program is scheduled to begin in model year 1999. Because the emissions reductions benefits from this program rely on fleet turnover, only limited reductions will be achieved in the first model year due to the limited number of vehicles in the fleet that will be meeting the standard.

- Accelerated vehicle scrappage results in higher fleet turnover and speeds up the benefits of programs such as the Tier 1 tailpipe standards if people replace their scrapped vehicles with new cars. Because of the uncertainty in benefits, this measure was not included in the final study.

4.1.1 Modeling Analyses

Base Case Controls and VMT Estimates

The base case motor vehicle projections include all of the mandatory control requirements of the Act. This includes enhanced I/M in MSA's with a population of 100,000 or more for all areas in the OTR, and basic I/M for moderate areas not required to implement enhanced I/M. In the case of enhanced I/M, the Act only mandates that the program apply to the urbanized portions of the MSA. Under the base case modeling scenario, no judgement was made as to whether specific counties would be exempt based on this provision; the enhanced I/M controls were applied to the entire MSA. The base case motor vehicle controls are summarized in Table 4-1.

Highway vehicle emissions are projected by combining estimated vehicle miles traveled (VMT) with MOBILE5a (see reference 2) emission factors. Base year VMT estimates are from the Interim 1990 Inventory. (See reference 3.) The VMT estimates were retained by county, vehicle type, and roadway classification. Ozone season daily VMT was estimated from annual VMT by applying seasonal and daily temporal allocation factors. (See reference 15.) Projection year VMT was calculated using national VMT growth from the MOBILE4.1 Fuel Consumption Model (see reference 16), which was scaled to each area based on expected population growth. Table 4-2 shows the national VMT projections and corresponding annual growth rates.

State-specific MOBILE5a emission factors were applied to the VMT estimates to calculate emissions. The ozone season temperatures and RVP's used in the modeling are the same values used for the vehicle refueling projections, as shown in Table 3-2. Each vehicle type/roadway classification was matched to an average speed used in the MOBILE5a modeling. The correspondence between roadway classifications and speeds is shown in Table 4-3.

Table 4-1. Base Case Motor Vehicle Controls
Attainment, Marginal, and Moderate Areas in the OTR

Program	Description
RVP	Phase II RVP minus a 0.3 psi margin of safety. For areas with a 7.8 psi limit, no safety margin is applied.
Tailpipe Standards	Federal Tier I standards are required nationally. Tier II standards are optional (the Act mandates a study investigating the need for the standards) and were not modeled.
Evaporative Test Procedure	The new Federal evaporative test procedure applies to all vehicles certified outside California.
I/M	Enhanced I/M was applied in MSA's with a population of 100,000 or more. Basic I/M was applied in moderate areas unless enhanced I/M is required.

Table 4-2. Current and Projected Nationwide Vehicle Miles Traveled

	Vehicle Miles Traveled (billions)		Equivalent Annual Growth Rate (percent per year)
	1990	1999	1990-1990
LDGV	1,169.22	1,361.35	1.7
LDGT	444.19	617.03	3.7
HDGV	55.70	72.02	2.9
Diesel	130.45	174.38	3.3
Total	1,799.56	2,224.78	2.4

NOTES: LDGV = light-duty gasoline vehicle
LDGT = light-duty gasoline truck
HDGV = heavy-duty gasoline vehicle

SOURCE: EPA, 1991f.

Table 4-3. Average Speeds by Roadway Classification and Vehicle Type (mph)

	Rural						Urban					
	Interstate	Principal Arterial	Minor Arterial	Major Collector	Minor Collector	Local	Interstate	Other Freeways & Expressways	Principal Arterial	Minor Arterial	Collector	Local
LDV	60	45	40	35	30	30	45	45	20	20	20	20
LDT	55	45	40	35	30	30	45	45	20	20	20	20
HDV	40	35	30	25	25	25	35	35	15	15	15	15

NOTES: LDV = light-duty vehicle
LDT = light-duty truck
HDV = heavy-duty vehicle

SOURCE: Derived from the Highway Performance Monitoring System Impact Model.

Enhanced I/M

Enhanced I/M modeling parameters are described in Table 4-4. These are based on each area meeting I/M performance standard requirements from the Inspection/Maintenance Program Requirements; Final Rule. (See reference 17.) States may vary the I/M program parameters (e.g., biennial versus annual, stringency of cutpoints, waiver rates) as long as the resulting emission benefits are equivalent to those of the model program. In fact, the guidance suggests a biennial program, which is generally more cost effective than an annual program. Emission reductions for enhanced I/M are measured incremental to Act requirements. In areas where basic I/M is required, the reductions for enhanced I/M are measured incremental to this baseline. This analysis assumes that all counties within MSAs of population greater than 100,000 implement enhanced I/M under baseline Act requirements. The Act requires enhanced I/M only within the *urbanized* portions of these areas. Thus, Act requirements may be overstated in this analysis. Benefits from extending enhanced I/M to non-urbanized portions of nonattainment areas or MSAs may be substituted for Stage II reductions.

Enhanced I/M shows comparable reductions in all areas where this measure not already required under the Act.

Reformulated Gasoline

Section 211(k) of the Act requires EPA to promulgate regulations establishing requirements for reformulated gasoline for conventional vehicles in the nine worst ozone nonattainment areas. This provision also allows other areas classified as marginal, moderate, serious, and severe to opt into the Federal reformulated gasoline program at the request of the Governor of the State. The final rules were published on February 16, 1994. (See reference 18.) The reformulated gasoline program will be implemented in two phases. Phase I begins on January 1, 1995 and will achieve a 15 to 17 percent reduction in both VOC emissions and toxic emissions from motor vehicles. Phase II begins on January 1, 2000 and will achieve a 25 to 29 percent VOC reduction, a 20 to 22 percent reduction in toxics emissions, and a 5 to 7 percent reduction in NO_x emissions.

Reformulated gasoline was modeled according to the Federal program requirements using the MOBILE5a reformulated gasoline routines. This simply involved setting an input flag within the MOBILE5a input file. The model then calculated the projection year emission factors using Phase I or Phase II reformulated gas, depending on the projection year. The reformulated gasoline program will be in Phase I in 1999, the year selected for comparability demonstration. Therefore, only the emissions

Table 4-4. Enhanced I/M Program Modeling Assumptions

I/M Program:	
Start year:	1996
Pre-1981 MYR stringency rate:	20%
Model years covered:	1986 - 2020
Waiver rate (pre-1981):	3%
Waiver rate (1981 and newer):	3%
Compliance rate:	96%
Inspection type:	Centralized
Inspection frequency:	Annual
Vehicle types covered:	LDGV, LDGT 1 & 2
Test Type:	1968 - 1985 MY 2500/Idle 1986 - 2020 MY Transient Cutpoints (g/mile): 0.80 HC 20.0 CO 2.0 NO_x
Anti-tampering Program:	
Start year:	1996
Model years covered:	1984 - 2020
Vehicle types covered:	LDGV, LDGT 1 & 2
Inspection type:	Centralized
Inspection frequency:	Annual
Compliance rate:	96%
Tampering inspections performed:	Catalyst, Fuel inlet restrictor
Evaporative System Pressure Test:	
Start year:	1996
Model years covered:	1983-2020
Vehicle types covered:	LDGV, LDGT 1 & 2
Inspection type:	Centralized
Inspection frequency:	Annual
Compliance rate:	96%
Functional Purge Test:	
Start year:	1996
Model years covered:	1986 - 2020
Vehicle types covered:	LDGV, LDGT 1 & 2
Inspection type:	Centralized
Inspection frequency:	Annual
Compliance rate:	96%

reductions attributable to Phase I were evaluated for possible comparability to Stage II reductions.

Table 4-5 includes data on emissions reductions from reformulated gasoline in all areas affected by the Stage II or comparable measure requirement. However, States should be aware that there are significant outstanding legal and technical issues regarding whether and how reformulated gasoline programs may be applied in attainment and incomplete data nonattainment areas. The EPA is currently exploring these issues. States should contact the EPA Office of Mobile Sources for further information.

The emission reductions achieved by reformulated gasoline depend on the mix of emission control measures already in place. Reformulated gasoline standards include a further reduction in gasoline RVP. Therefore, a lower RVP in the baseline lessens the effectiveness of reformulated gasoline. To a smaller degree, the impacts of reformulated gasoline are also dependent on whether the area is subject to an enhanced I/M program in the baseline.

The majority of areas will achieve comparable reductions with reformulated gasoline. Exceptions in 1999 include the two areas in New Jersey; Portland, ME; Manchester, NH; Albany and Buffalo, NY; and Erie, Harrisburg, and Pittsburgh, PA. The common characteristic of these areas is that all require enhanced I/M under the Act that reduces the baseline from which reformulated gasoline reductions are measured.

Because opting into the Federal reformulated gasoline program is a voluntary action, the program may be selected as a comparable measure in marginal and moderate areas if it is shown to achieve emissions reductions equal to or greater than Stage II. However, section 184(b)(2) requires that either Stage II or the comparable measure be reflected in the SIP. Therefore, the opt-in letter from the Governor would need to undergo the SIP rulemaking process.

Combination of Measures

Enhanced I/M and reformulated gasoline programs were combined to estimate the overall benefit of the two measures. The benefits of motor vehicle measures are not additive because the controls may be affecting the same emission component (i.e., exhaust, evaporative loss, resting loss, or running loss). Separate MOBILE5a runs were therefore completed combining the measures and emissions projected using the resulting emission factors.

The estimated emission reductions for each of the motor vehicle measures, as well as the combination of the measures, are shown in Table 4-5. The same areas that show comparable benefits

Table 4-5. Motor Vehicle Control Measure VOC Reductions Projection Year 1999

Ozone Area	VOC Reduction (tpd)		
	Enhanced I/M	Reformulated Gasoline	Enhanced + Reform
Delaware			
Sussex County	3.10	1.25	3.79
Maine			
Hancock & Waldo Counties	1.73	0.62	2.06
Knox & Lincoln Counties	1.49	0.53	1.77
Lewiston-Auburn	4.26	1.54	5.08
Portland	NA*	1.76	NA*
Franklin County	0.72	0.26	0.86
Oxford County	1.20	0.43	1.43
Somerset County	1.02	0.37	1.22
Attainment Counties	6.61	2.38	7.87
Maryland			
Kent & Queen Anne's Counties	1.18	0.47	1.43
Attainment Counties	7.22	3.84	9.70
New Hampshire			
Manchester	NA	2.00	NA
Belknap County	1.00	0.39	1.21
Chesire County	1.45	0.57	1.76
Sullivan County	0.78	0.30	0.95
Attainment Counties	3.14	1.23	3.83
New Jersey			
Allentown-Bethlehem-Easton	NA	0.40	NA
Atlantic City	NA	1.42	NA
New York			
Albany-Schenectady-Troy	NA	3.50	NA
Buffalo-Niagara Falls	NA	4.13	NA
Essex County	0.75	0.29	0.91
Jefferson County	1.63	0.63	1.97
Poughkeepsie	NA	1.28	NA
Attainment Counties	30.97	21.08	46.65

*NA = not applicable, enhanced I/M is already required by the Act in this area. All counties within the area were assumed to apply enhanced I/M under the Act. If certain counties are exempt (i.e., not urbanized), then reductions in these counties would be creditable for substitution.

Table 4-5 (continued)

Ozone Area	VOC Reduction (tpd)		
	Enhanced I/M	Reformulated Gasoline	Enhanced + Reform
Pennsylvania			
Allentown-Bethlehem-Easton	NA	2.08	NA
Altoona	NA	0.50	NA
Erie	NA	0.89	NA
Harrisburg-Lebanon-Carlisle	NA	2.56	NA
Johnstown	NA	1.02	NA
Lancaster	NA	1.60	NA
Pittsburgh-Beaver Valley	NA	9.87	NA
Reading	NA	1.23	NA
Scranton-Wilkes-Barre	NA	2.59	NA
York	NA	1.78	NA
Youngstown-Warren-Sharon	NA	0.51	NA
Crawford County	1.78	0.70	2.17
Franklin County	2.25	0.89	2.75
Greene County	0.87	0.34	1.06
Juniata County	0.43	0.17	0.53
Lawrence County	1.95	0.77	2.38
Northumberland County	1.76	0.70	2.14
Pike County	0.41	0.16	0.50
Schuylkill County	2.86	1.13	3.49
Snyder County	0.70	0.28	0.86
Susquehanna County	0.85	0.34	1.04
Warren County	0.95	0.38	1.16
Wayne County	0.74	0.29	0.91
Attainment Counties	15.98	7.28	20.45
Vermont			
Attainment Counties	9.17	4.18	11.78

*NA = not applicable, enhanced I/M is already required by the Act in this area. All counties within the area were assumed to apply enhanced I/M under the Act. If certain counties are exempt (i.e., not urbanized), then reductions in these counties would be creditable for substitution.

with enhanced I/M alone also show comparable benefits with enhanced I/M and reformulated gasoline combined.

4.1.2 Cost Effectiveness

Enhanced I/M

The EPA has developed estimates of inspection and repair costs for enhanced I/M programs. (See reference 19.) A biennial enhanced I/M program that would satisfy the requirements of EPA's final rule has an estimated net annual cost of $5.4 million per year per million vehicles. If all program costs are allocated to VOC reductions, the biennial enhanced I/M program has an annual cost-effectiveness of $880 per ton of VOC. If program costs are allocated among the three criteria pollutants reduced by enhanced I/M -- NO_x, carbon monoxide (CO), and VOC -- the cost per ton of VOC reduced is estimated to be $500 for a biennial enhanced I/M program. Although EPA's performance standards are based on an annual program, most areas required to implement enhanced I/M are expected to implement biennial programs that have been shown to be more cost effective. It should be noted that EPA's estimates of inspection and repair costs are based on programs implemented in urbanized areas. Costs for rural areas may be higher because fewer cars would be serviced by each inspection station. Inconvenience to vehicle owners in rural areas may also be higher than in urban areas because distances to inspection stations may be greater in less populated areas.

Reformulated Gasoline

The final rule for reformulated gasoline estimates an incremental cost of approximately 3 to 5 cents per gallon for Phase I reformulated gasoline above the cost of conventional gasoline.

The cost per ton of VOC reduced varies from State to State based on the estimated emission benefit. The cost has generally been estimated to be less than $5,000 per ton. Emission benefits depend on the baseline from which reductions are measured. Areas with enhanced I/M programs and lower RVP values in the baseline show lower benefits attributable to reformulated gasoline. The costs of producing Phase I reformulated gasoline result from the required addition of oxygenates to gasoline, RVP reductions, and refinery processing changes.

4.2 STATIONARY SOURCE VOC CONTROL MEASURES

The stationary source measures analyzed by the study are more stringent controls on existing sources for several selected source categories.

The following measures were considered but not included in the final study:

- Control of industrial adhesives was considered as a potential measure. The 1990 Interim Inventory emission estimates for industrial adhesives are based on a national material balance. Resulting emissions are higher than any previous estimates and are considered uncertain. Because of this uncertainty, this measure is not included in the final study, but may be independently analyzed by the States.

- RACT to smaller sources was also considered as a potential measure. RACT to 50 tpy is already required for VOC sources in the OTR (severe areas are required to install RACT on 25 tpy and greater sources). The Interim Inventory point source data base is based on the 1985 NAPAP inventory, which has a major stationary source size cutoff of 100 tpy for VOC. Because the inventory does not cover the smaller sources and because the fraction of area source emissions in the 25 or 10 to 50 tpy range is unknown, this measure cannot be adequately assessed.

- Increased offsets were also considered. This measure could include extending offsets to smaller sources or increasing the offset ratio. Benefits are difficult to quantify because growth cannot be accurately allocated between major new sources and modifications (subject to offsets) and increases in activity or operating rates (not subject to offsets unless a permit modification is triggered).

- Emissions from the application of pesticides can be reduced through reformulation, reduced use of fumigants, and increases in application efficiency. Reformulation of pesticides is a lengthy and relatively expensive process since the reformulated product must undergo testing and be permitted for use. This measure is being considered in California and other areas. The California Federal Implementation Plan (FIP) calls for a study of pesticide formulations leading to the establishment of standards to reduce overall emissions in the range of 20 to 40 percent. Because of the uncertainty in potential benefits and costs, this measure was not further analyzed.

More Stringent Controls on Existing Sources

Stationary source VOC control measures were analyzed using ERCAM-VOC. Base year emissions are from the 1990 Interim Inventory. Emissions are projected to future years using State/2-digit SIC earnings growth and population projections.

The Act requires RACT for major sources (those emitting 50 tpy VOC) in the OTR. To represent a more stringent set of controls than RACT, best available control technology (BACT) or new source performance standard (NSPS) level controls were applied to existing major (point) sources, or controls were applied to area source emitters that would be expected to be below the source size cutoff for RACT. The controls applied are based on the set of existing control measures in ERCAM-VOC. It is likely that there are additional source categories to which additional controls could be applied; however, these controls may vary significantly by area, so no attempt has been made to identify new control techniques.

More stringent controls were applied to five source categories as follows:

SOCMI fugitives -- Synthetic organic chemical manufacturing industry (SOCMI) fugitives are controlled through improved equipment and leak detection and repair (LDAR) programs. The baseline (RACT) control level assumed for this area source category is 37 percent. A more stringent program was applied at a 56 percent VOC emission reduction under the more stringent control on existing sources scenario. The estimated cost effectiveness is $200 per ton from uncontrolled levels. The estimated incremental (incremental to RACT level control) cost effectiveness is $375 per ton.

Petroleum refinery fugitives -- Petroleum refinery fugitive (equipment leak) emissions are controlled through equipment (e.g., seals) and maintenance (e.g., leak detection and repair (LDAR)). A 69 percent control level was applied to represent RACT. A control level of 93 percent was applied under the more stringent control scenario. The higher level of control can be achieved through more frequent inspections for leaks and more sophisticated equipment, such as double mechanical seals or seals with a buffer or barrier fluid. The estimated cost effectiveness is $2,030 per ton from uncontrolled levels. The estimated incremental cost effectiveness is $8,200 per ton reduced.

Pharmaceutical manufacturing -- Baseline controls for this area source category (which includes mainly fugitive emissions) include an LDAR program at an estimated control level of 37 percent. A more stringent LDAR program and improved equipment are applied to achieve a 56 percent reduction in the more stringent control scenario. The estimated cost is $340 per ton from uncontrolled levels. The incremental cost is estimated to be $480 per ton.

Bakeries -- No controls are applied to this area source category in the baseline (emission levels are assumed to be below the major source size cutoff). An 80 percent control level, representing afterburners, is applied in the more stringent control case. Cost effectiveness is estimated to be $1,275 per ton reduced.

Small drycleaners -- No controls are applied to this area source category in the baseline scenario. A 70 percent control, representing recovery dryers, is applied in the more stringent control scenario. This includes small commercial drycleaners using both petroleum solvent and perchloroethylene. Approximately half of the emissions in this category are from perchloroethylene drycleaning. Reductions from these operations are included here but may not be creditable, since it has been proposed that perchloroethylene be exempted as a VOC. Cost effectiveness is estimated to be $200 per ton reduced.

Emission reductions attributable to more stringent controls on existing stationary sources from the RACT-level or uncontrolled baseline are shown in Table 4-6. These emissions estimates represent the total emissions reductions if the existing sources for the five source categories listed above are controlled to the more stringent level. Applying these VOC stationary source control measures does not provide comparable benefits for any area. A detailed summary by source category is given in Appendix B.

Table 4-6. Stationary Source Control Measure VOC Emission Reductions Projection Year 1999

Ozone Area	VOC Reduction (tpd) More Stringent Existing Source Controls
Delaware	
Sussex County	0.17
Maine	
Hancock & Waldo Counties	0.05
Knox & Lincoln Counties	0.03
Lewiston-Auburn	0.56
Portland	0.79
Franklin County	0.00
Oxford County	0.01
Somerset County	0.01
Attainment Counties	0.25
Maryland	
Kent & Queen Anne's Counties	0.07
Attainment Counties	0.52
New Hampshire	
Manchester	1.05
Belknap County	0.03
Chesire County	0.09
Sullivan County	0.00
Attainment Counties	0.10
New Jersey	
Allentown-Bethlehem-Easton	0.09
Atlantic City	0.36
New York	
Albany-Schenectady-Troy	1.07
Buffalo-Niagara Falls	1.82
Essex County	0.00
Jefferson County	0.07
Poughkeepsie	0.14
Attainment Counties	5.19

Table 4-6 (continued)

Ozone Area	VOC Reduction (tpd) More Stringent Existing Source Controls
Pennsylvania	
Allentown-Bethlehem-Easton	0.69
Altoona	0.19
Erie	0.30
Harrisburg-Lebanon-Carlisle	0.66
Johnstown	0.12
Lancaster	0.63
Pittsburgh-Beaver Valley	3.48
Reading	0.79
Scranton-Wilkes-Barre	0.61
York	0.72
Youngstown-Warren-Sharon	0.16
Crawford County	0.22
Franklin County	0.04
Greene County	0.02
Juniata County	0.00
Lawrence County	0.02
Northumberland County	0.17
Pike County	0.02
Schuylkill County	0.05
Snyder County	0.02
Susquehanna County	0.00
Warren County	0.02
Wayne County	0.01
Attainment Counties	0.81
Vermont	
Attainment Counties	0.77

5.0 NO_x CONTROL MEASURES

Under EPA's interpretation of section 184(b)(2), States have the option of adopting comparable NO_x control measures instead of Stage II. Section 5.1 provides the method for determining what level of NO_x emission reductions is comparable to Stage II VOC emissions reductions for a particular area and therefore can be substituted. NO_x may not be substituted for VOC in areas where a waiver under section 182(f) of the Act from some or all NO_x requirements has been obtained because such a waiver indicates that NO_x reductions are either excess and not necessary for attainment, or NO_x reductions are otherwise not beneficial.

The NO_x control measures evaluated in the study have been divided into three categories: motor vehicle, utility point source, and non-utility point source. The emissions reduction estimates for these categories are provided in sections 5.2, 5.3, and 5.4, respectively. Calculations of the VOC equivalency for the NO_x emissions reductions, according to the methodology in section 5.1, are provided. If a measure controls both NO_x and VOC emissions (see Chapter 3 for VOC emissions reductions estimates), the emissions reductions may be combined to yield a total emissions reduction estimate for the measure.

5.1 NO_x SUBSTITUTION METHODOLOGY

To determine whether a NO_x control measure achieves comparable emissions reductions to Stage II, the NO_x reductions for the measure and Stage II VOC reductions are compared on the basis of percentage reductions of the respective NO_x and VOC base year anthropogenic emission inventories (rather than on a ton-per-ton basis). For example, a 10 percent reduction in the NO_x inventory would be considered comparable to a 10 percent reduction in the VOC inventory. (By this method, the ton-per-ton equivalency will vary by area according to the ratio of the VOC and NO_x emissions inventories.)

Comparability determinations for NO_x control measures are illustrated by the following example.

Example A. Consider an area with a 1990 base year VOC emissions inventory of 500 tons per day (tpd) and a NO_x emissions inventory of 400 tpd. Stage II, more stringent controls on coal-fired boilers, and enhanced I/M (which controls both VOC and NO_x) are analyzed below for projection year 1999.

Assume Stage II control yields a 2 percent reduction from the 1990 VOC base year emissions inventory (10 tpd reduction divided by 500 tpd total). Therefore, to be comparable, a NO_x control measure must achieve a reduction of 2 percent or more in

Example A

Control Measure	VOC Reduction tpd	VOC Reduction %	NO_x Reduction tpd	NO_x Reduction %
Stage II	10	2	--	--
More Stringent Controls on Coal-Fired Utilities	0	0	9	2.3
Enhanced I/M	7	1.4	1.5	0.4

emissions from the 1990 NO_x base year emissions inventory (8 tpd or more reduction from 400 tpd total). More stringent control for NO_x on coal-fired utilities would be considered comparable where this measure yields a reduction of 2.3 percent from base year emission levels (9 tpd NO_x reduction divided by 400 tpd NO_x total). Enhanced I/M reduces both VOC and NO_x emissions. Therefore, the VOC reductions and the NO_x reductions may be summed for this measure. Enhanced I/M would not be considered comparable because the sum of the percent NO_x and VOC emissions reductions is only 1.8 percent: 1.4 percent for VOC (7 tpd VOC reduction divided by 500 tpd VOC total) and 0.4 percent for NO_x (1.5 tpd NO_x reduction divided by 400 tpd NO_x total).

NO_x Substitution Ratios

The calculations for comparing emissions reductions using the percent of inventory method can be simplified by deriving the NO_x substitution ratio for an area. The NO_x substitution ratio is simply the NO_x inventory divided by the VOC inventory. In Example A, the NO_x substitution ratio would be 0.8 (400 tpd NO_x divided by 500 tpd VOC). Thus, 0.8 tpd NO_x is comparable to 1 tpd VOC for that area. The NO_x substitution ratio will vary area by area according to the relative amounts of VOC and NO_x emissions.

The NO_x emissions reductions estimated for an alternative measure can be divided by the NO_x substitution ratio to convert the NO_x emissions to comparable VOC reductions. The VOC reductions can then be compared on a ton-for-ton basis with the Stage II VOC reductions. This is illustrated by the following example.

Example B. This example uses the same scenario described in Example A. The 1990 NO_x inventory is 400 tpd and the 1990 VOC inventory is 500 tpd. Dividing the NO_x inventory by the VOC inventory produces a NO_x substitution ratio of 0.8. In the table below, the NO_x emissions reductions have been divided by the NO_x substitution ratio to produce the VOC equivalent reductions for the measures.

Example B

Control Measure	VOC Reduction (tpd)	NO_x Reduction (tpd)	Comparable VOC Reduction (tpd)
Stage II	10	--	--
More Stringent Controls on Coal-Fired Utilities	0	9	11.3
Enhanced I/M	7	1.5	1.9

Stage II achieves a VOC reduction of 10 tpd. More stringent NO_x control on coal-fired utilities is comparable because it achieves NO_x emissions reductions comparable to 11.3 tpd reduction in VOC. Enhanced I/M is not comparable because it achieves only an 8.9 tpd reduction in VOC emissions (7 tpd VOC + 1.9 tpd in VOC comparable emissions).

In data tables in this chapter, all of the NO_x emissions reductions estimates for the measures evaluated have been converted into comparable VOC equivalent reductions for ease in comparing the reductions to the applicable Stage II VOC emissions reductions. The ratios for determining equivalent VOC reductions are shown in Table 5-1.

The method for substituting NO_x for the Stage II or comparable measure requirement is based, in part, on the NO_x Substitution Guidance (see reference 20) developed for States to use to meet post-1996 emission reduction requirements under section 182(c)(2)(B) of the Act. Section 182(c)(2) requires each serious and above ozone nonattainment area to submit a SIP revision by November 15, 1994, which describes how the area will achieve an actual VOC emissions reduction of 3 percent per year, averaged over consecutive 3-year periods beginning November 15, 1996 until the area's attainment date. Substitution of NO_x emissions reductions is permitted if certain conditions are met.

Central to both substitution procedures is that NO_x and VOC emissions reductions are compared on a percentage of the base year inventory basis rather than on a ton-per-ton basis. However, there are some significant differences. The two NO_x substitution methods differ in regard to applicability and the approvability criteria for the substitution. The post-1996 NO_x substitution guidance applies only to serious and above ozone nonattainment areas. The approvable degree of NO_x substitution in the rate-of-progress plans is linked to an area's attainment demonstration. NO_x emissions reductions must be shown to be necessary for attainment and be included in the area's SIP control strategy before they may be substituted for VOC emissions reductions in the rate-of-progress plans.

Table 5-1. NO_x to VOC Substitution Ratios - Percent of Inventory Method

Ozone Area	1990 VOC (tpd)	1990 NO_x (tpd)	NO_x to VOC Ratio
Delaware			
Sussex County	173.3	67.8	0.4
Maine			
Hancock & Waldo Counties	14.5	13.6	0.9
Knox & Lincoln Counties	11.3	10.6	0.9
Lewiston-Auburn	39.4	26.4	0.7
Portland	79.7	69.1	0.9
Franklin County	5.7	9.2	1.6
Oxford County	11.9	9.6	0.8
Somerset County	9.8	10.3	1.0
Attainment Counties	66.6	56.7	0.9
Maryland			
Kent & Queen Anne's Counties	11.4	9.8	0.9
Attainment Counties	128.7	116.1	0.9
New Hampshire			
Manchester	82.4	102.2	1.2
Belknap County	8.5	6.7	0.8
Chesire County	12.4	9.2	0.7
Sullivan County	6.4	4.9	0.8
Attainment Counties	27.1	24.4	0.9
New Jersey			
Allentown-Bethlehem-Easton	21.6	22.1	1.0
Atlantic City	52.6	70.0	1.3
New York			
Albany-Schenectady-Troy	196.2	135.6	0.7
Buffalo-Niagara Falls	226.7	237.1	1.0
Essex County	6.5	7.4	1.1
Jefferson County	17.0	13.4	0.8
Poughkeepsie	53.1	32.8	0.6
Attainment County	937.8	719.4	0.8
Pennsylvania			
Allentown-Bethlehem-Easton	102.2	116.0	1.1
Altoona	22.1	19.7	0.9
Erie	184.3	45.1	0.2

Table 5-1 (continued)

Ozone Area	1990 VOC (tpd)	1990 NO_x (tpd)	NO_x to VOC Ratio
Harrisburg-Lebanon-Carlisle	106.8	80.3	0.8
Johnstown	42.2	33.9	0.8
Lancaster	83.2	62.2	0.7
Pittsburgh-Beaver Valley	441.0	658.2	1.5
Reading	64.3	58.3	0.9
Scranton-Wilkes-Barre	131.3	91.2	0.7
York	82.4	133.7	1.6
Youngstown-Warren-Sharon	22.6	20.0	0.9
Crawford County	26.0	18.9	0.7
Franklin County	22.7	16.1	0.7
Greene County	7.4	115.2	15.6
Juniata County	4.4	3.3	0.8
Lawrence County	17.6	39.9	2.3
Northumberland County	18.4	12.5	0.7
Pike County	12.5	3.3	0.3
Schuylkill County	28.2	19.5	0.7
Snyder County	7.2	37.7	5.3
Susquehanna County	56.4	6.2	0.1
Warren County	16.6	16.2	1.0
Wayne County	7.0	5.3	0.8
Attainment Counties	215.6	543.2	2.5
Vermont			
Attainment Counties	110.5	77.9	0.7

NOTE: Base year anthropogenic emissions are taken from the 1990 Interim Inventory. (See reference 3.)

In contrast, the Stage II Comparability Study NO_x substitution guidance applies to moderate, marginal, and incomplete data ozone nonattainment areas and attainment portions of the OTR.[1] Most of these areas are already at ornear attainment and are not required to submit attainment demonstrations. Therefore, approvability of the degree of NO_x substitution for the purposes of this requirement cannot be related to attainment demonstrations.

Instead, EPA believes any mix of VOC and NO_x emissions reductions is permissible to meet the comparability requirement. This is supported by the findings of the National Academy of Science report Rethinking the Ozone Problem in Urban and Regional Air Pollution (see reference 21) and the results of Regional Oxidant Model (ROM) simulations, which suggest that substantial reductions of both NO_x and VOC emissions will be needed to bring the OTR into attainment.

5.2 MOTOR VEHICLE CONTROL MEASURES

The enhanced I/M program was evaluated as a potential comparable NO_x control measure for motor vehicles. This control measure was also evaluated for VOC emissions reductions in Chapter 4. The program parameters are described in that chapter. The projection methodology and the modeling assumptions used to examine this measure for NO_x control are identical to those used for the VOC analysis. These are described in detail in Chapter 4. Also provided in Chapter 4 are the cost estimates for implementing this measure. Federal reformulated gas was analyzed as a motor vehicle control measure for VOC, but it is not included in this section because the Act only requires that Phase I reformulated gasoline not increase NO_x emissions. Phase II reformulated gasoline will reduce NO_x emissions; however, Phase II reformulated gasoline does not begin until the year 2000. Other motor vehicle measures were considered, as discussed in Chapter 4, but not included in the final study.

The estimated NO_x reductions from enhanced I/M are shown in Table 5-2. No benefit is shown for areas where enhanced I/M programs are already required. For the purposes of making a comparability determination, an area can only take credit for emissions reductions from control measures that are in excess of control measures prescribed under the Act. As discussed in Section 5.1, the NO_x and VOC emissions reductions may be combined

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[1]Technically, the section 184(b)(2) requirement to adopt Stage II or a comparable measure, and thus the related NO_x substitution guidance, applies to all areas in the OTR, including serious and severe areas. However, as discussed in Chapter 2.0, because States with serious and severe areas must adopt Stage II under section 182(b)(3), they cannot take advantage of the option to adopt a comparable measure.

Table 5-2. Motor Vehicle NO_x Reductions - Projection Year 1999

Ozone Area	Enhanced I/M NO_x (tpd)	Enhanced I/M Comparable VOC (tpd)
Delaware		
Sussex County	1.81	4.53
Maine		
Hancock & Waldo Counties	1.13	1.26
Knox & Lincoln Counties	0.98	1.09
Lewiston-Auburn	2.33	3.33
Portland	NA*	NA
Franklin County	0.48	0.30
Oxford County	0.78	0.98
Somerset County	0.65	0.65
Attainment Counties	3.94	4.38
Maryland		
Kent & Queen Anne's Counties	0.83	0.92
Attainment Counties	4.90	5.44
New Hampshire		
Manchester	NA	NA
Belknap County	0.62	0.78
Chesire County	0.89	1.27
Sullivan County	0.46	0.58
Attainment Counties	1.99	2.21
New Jersey		
Allentown-Bethlehem-Easton	NA	NA
Atlantic City	NA	NA
New York		
Albany-Schenectady-Troy	NA	NA
Buffalo-Niagara Falls	NA	NA
Essex County	0.48	0.44
Jefferson County	0.96	1.20
Poughkeepsie	NA	NA
Attainment Counties	18.19	22.74

*NA = not applicable; enhanced I/M is mandated by the Act for these areas.

Table 5-2 (continued)

Ozone Area	Enhanced I/M NO$_x$ (tpd)	Enhanced I/M Comparable VOC (tpd)
Pennsylvania		
Allentown-Bethlehem-Easton	NA	NA
Altoona	NA	NA
Erie	NA	NA
Harrisburg-Lebanon-Carlisle	NA	NA
Johnstown	NA	NA
Lancaster	NA	NA
Pittsburgh-Beaver Valley	NA	NA
Reading	NA	NA
Scranton-Wilkes-Barre	NA	NA
York	NA	NA
Youngstown-Warren-Sharon	NA	NA
Crawford County	0.95	1.36
Franklin County	1.20	1.71
Greene County	0.47	0.03
Juniata County	0.24	0.30
Lawrence County	1.00	0.43
Northumberland County	0.89	1.27
Pike County	0.23	0.77
Schuylkill County	1.46	2.09
Snyder County	0.38	0.07
Susquehanna County	0.47	4.70
Warren County	0.51	0.51
Wayne County	0.40	0.50
Attainment Counties	8.52	3.41
Vermont		
Attainment Counties	5.76	8.23

*NA = not applicable; enhanced I/M is mandated by the Act for these areas.

to determine comparability to Stage II VOC reductions. As shown in Chapter 4, areas where enhanced I/M is applicable show comparable benefits with the VOC reductions alone. Examining the NO_x benefits alone shows comparable benefits in all applicable areas except Greene, Lawrence, Snyder, and the attainment counties in Pennsylvania. These latter areas all have NO_x to VOC ratios greater than 2.

5.3 UTILITY CONTROL MEASURES

Utility boilers are affected by both Title I and Title IV of the Act. Under Title I, utility units are subject to NO_x RACT requirements for major stationary sources (100 tpy or greater in the OTR). Through Title IV, many utility units will be subject to NO_x emission limits.

The NO_x control measures examined for utility boilers are lowering the NO_x RACT source size cutoff from 100 tpy to 25 tpy, and requiring more stringent controls for existing major sources (i.e., 100 tpy or greater sources). Table 5-3 shows the control technologies selected to represent RACT and the more stringent control for utility as well as non-utility point sources (see section 5.4 for the analysis of the latter source category).

The 1990 Interim Inventory was used as the basis for evaluating control measures for fossil-fuel steam utility units. The utility component of the inventory includes all plants of at least 10 megawatts and that have at least one operating boiler. An electric plant is a station containing prime movers, electric generators, and auxiliary equipment for converting mechanical, chemical, and/or fission energy into electric energy. The Interim Inventory utility data base contains fossil-fuel fired boilers only. Electric utilities include facilities which produce electricity primarily for use by the public.

NO_x reductions expected to be achieved through these controls are shown in Table 5-4. The emissions reductions broken down by boiler type are given in Table C-1 in Appendix C. Areas not appearing on these tables do not have existing utility units and therefore have no emissions from utility boilers. Areas appearing on the results tables all have utility boilers; however, the resulting emission reductions are sometimes (often for RACT) zero. This indicates that the control measures applied do not result in emission reductions in excess of existing levels and Act requirements. Therefore, the controls could not be considered as potential comparable measures.

Table 5-3. NO_x RACT and More Stringent Control Technologies

Source Category	RACT Control	Percent Control	Cost ($/ton)	More Stringent Control	Percent Control	Cost ($/ton)
Utility Boilers - PC Wall Fired	LNB	45	305	SCR	79	2,435
Utility Boilers - PC Tangential	LNB	29	880	SCR	79	1,645
Utility Boilers - Oil/Gas Wall Fired	BOOS + FGR	39	645	SCR	72	3,750
Utility Boilers - Oil/Gas Tangential	BOOS + FGR	42	940	SCR	75	5,500
Utility Boilers - Cyclone	NGR	53	650	NGR	53	650
Industrial Boilers - PC	LNB	50	1,350	SCR	75	6,600
Industrial Boilers - Stoker	SNCR	55	1,800	SNCR	55	1,800
Industrial Boilers - Residual Oil	LNB	50	620	SCR	80	2,450
Industrial Boilers - Distillate Oil	LNB	50	1,180	SCR	80	3,950
Industrial Boilers - Natural Gas	LNB	50	770	SCR	80	3,000
IC Engines - Natural Gas	AF + IR	30	551	L - E	87	618
IC Engines - Oil	IR	25	518	SCR	80	1,540
Gas Turbines - Natural Gas	LNB	84	236	SCR + Steam Injection	95	5,581
Gas Turbines - Oil	Water Injection	70	1,166	SCR + Water Injection	94	2,835
Process Heaters - Natural Gas	ULNB	75	532	LNB + SCR	88	3,905
Process Heaters - Distillate Oil	ULNB	74	735	LNB + SCR	92	6,340
Process Heaters - Residual Oil	ULNB	73	442	LNB + SCR	91	3,820
Adipic Acid Manufacturing Plants	Thermal Reduction	81	459	Thermal Reduction	81	459
Nitric Acid Manufacturing Plants	Extended Absorption	95	173	NSCR	98	601

Abbreviations:

LNB = low NO_x burner
LEA = low excess air
BOOS = burners out of service
FGR = flue gas reburning
NGR = natural gas reburning
SNCR = selective non-catalytic reduction
AF = air-to-fuel (ratio)
IR = ignition timing retard
ULNB = ultra-low NO_x burner
SCR = selective catalytic reduction
L-E = low emission
IC = internal combustion
NSCR = non-selective catalytic reduction

Table 5-4. Utility Control Measure Emission Reductions Projection Year 1999

	RACT to 25 tpy**		More Stringent Control to 100 tpy**	
Ozone Area*	NO_x (tpd)	Comparable VOC	NO_x (tpd)	Comparable VOC
Delaware				
Sussex County	0.00	0.00	21.40	53.50
Maine				
Knox & Lincoln Counties	0.00	0.00	0.03	0.03
Portland	0.00	0.00	5.08	5.64
Attainment Counties	0.00	0.00	0.00	0.00
Maryland				
Attainment Counties	0.00	0.00	5.27	5.86
New Hampshire				
Manchester	0.00	0.00	0.00	0.00
New Jersey				
Atlantic City	0.00	0.00	1.09	0.84
New York				
Albany-Schenectady-Troy	0.00	0.00	8.37	11.96
Buffalo-Niagara Falls	0.00	0.00	43.67	43.67
Attainment Counties	0.00	0.00	57.18	71.48
Pennsylvania				
Allentown-Bethlehem-Easton	0.00	0.00	25.82	23.47
Altoona	0.00	0.00	0.00	0.00
Erie	0.00	0.00	3.92	19.60
Lancaster	0.00	0.00	0.00	0.00
Pittsburgh-Beaver Valley	0.00	0.00	183.73	122.49
Reading	0.00	0.00	6.14	6.82
Scranton-Wilkes-Barre	0.00	0.00	0.00	0.00
York	0.00	0.00	45.67	28.54
Greene County	0.00	0.00	45.94	2.94
Lawrence County	0.00	0.00	11.28	4.90
Snyder County	0.00	0.00	14.79	2.79
Warren County	0.00	0.00	0.00	0.00
Attainment Counties	0.00	0.00	179.39	71.76
Vermont				
Attainment Counties	0.00	0.00	0.00	0.00

NOTES: *Areas not appearing on the table do not have existing utility boilers and therefore have zero emissions.

**Zeros under RACT or more stringent control indicate that there are no additional reductions (above the Act requirements) for this measure. RACT to 25 tpy shows no reductions because utility boilers in these areas all emit at levels greater than the major source size cutoff.

5.3.1 Modeling Assumptions

Ozone season daily emissions for utility boilers were estimated from annual emissions using seasonal and daily temporal allocation factors developed for the 1985 NAPAP Inventory. (See reference 15.) Temporal allocation factors were used because operational data (seasonal throughput, weeks per year, days per week) were not available for utilities in the Interim Inventory. The temporal factors are State- and SCC (boiler type)-specific. The typical weekday factor was used in conjunction with the summer seasonal allocation factor to estimate ozone season daily emissions.

Growth in emissions from existing sources occurs through increased capacity utilization. Capacity utilization refers to the actual power generation provided annually by a unit compared with the potential output if the unit operated 24 hours per day for 365 days per year. Growth in capacity utilization is a function of fuel type, unit age, and State growth projections. Projected capacity utilization for 1999 was estimated using average capacity utilization factors, which were determined for each boiler-fuel type with data from the Interim Inventory years 1987 through 1991. Where limited data were available, State averages for each boiler-fuel type were used as the projected capacity utilization. Additional power generation demands not met by existing units would require new unit construction.

Growth estimates indicate that additional units will be needed in many areas; however, since these new units will be subject to new source review requirements, these units will already be required to operate at the more stringent control levels modeled in this analysis.

Determining NO_x RACT and Title IV NO_x Control Measures

In order to determine the emissions reductions attributable to additional NO_x control measures, first a baseline scenario was developed that included NO_x controls to represent NO_x RACT applied to major stationary sources (100 tpy or greater) (as required by the Act) and NO_x control measures to meet the acid deposition provisions of Title IV.

Title IV NO_x standards are 0.45 lb/MMBtu for tangentially fired coal boilers and 0.5 lb/MMBtu for dry bottom wall-fired coal boilers. The Title IV standard assumed for the remaining coal-fired boilers is 1.0 lb/MMBtu. Phase I units are subject to Title IV standards in 1996. Phase I units include the 260 dirtiest SO_2 emitting units. In addition to being classified as Phase I, the units must operate at least 50 percent on coal (on a Btu basis) to be subject to the Title IV NO_x standard. All units are required to comply with Title IV NO_x limits under Phase II beginning in 2002. Again, the units must operate at least 50 percent on coal.

The Nitrogen Oxides Supplement to the General Preamble for the Implementation of Title I of the Clean Air Act Amendments of 1990 (NO_x General Preamble) (see reference 22) specifies NO_x RACT limits of 0.2 lb/MMBtu for tangentially fired oil and gas boilers and 0.3 lb/MMBtu for wall-fired oil and gas boilers. The NO_x RACT limits for coal-fired boilers are equivalent to the Title IV acid deposition limits.

Controls modeled to meet RACT and Title IV standards are described below. Selection of the particular controls was based on a recent EPA report that evaluated NO_x controls for existing utility boilers in the NESCAUM region. (See reference 19.) One control technique was chosen for each fuel/firing type of utility boiler in the Interim Inventory. The selected control is applied to all boilers with current NO_x emission rates that are more than 10 percent above the Title IV standard. Boilers emitting within 10 percent of the standard were assumed to be able to make minor combustion modifications to achieve the standard.

Coal Fired, Dry Bottom, Wall -- If the boiler does not meet the Title IV standard or is required to install RACT, low NO_x burner (LNB) was applied. LNB is estimated to achieve a 45 percent reduction in emissions. Based on the utility boilers in the OTR, this is sufficient for most to achieve the necessary reductions. Overfire air (OFA), with a control efficiency of 21 percent, will not achieve the reductions necessary to meet Title IV requirements.

Coal Fired, Tangential -- LNB was also applied to tangentially fired coal boilers. The estimated reduction is 29 percent. This proved to be sufficient to bring all boilers into compliance with the Title IV standard.

Coal, Cyclone -- Natural gas reburning (NGR) was applied to cyclone boilers at a 53 percent reduction. NGR is the only control technique applicable to cyclone boilers based on the EPA/NESCAUM study.

Oil, Wall -- Burners out of service (BOOS) plus (+) fuel gas reburning (FGR) was applied to wall-fired residual and distillate oil utility boilers not meeting the RACT standard (being within 10 percent of the standard). While FGR alone will achieve the necessary reductions in some cases, BOOS + FGR is more cost effective. LNB is as effective in reducing NO_x, but is more costly than BOOS + FGR. BOOS + FGR provides a 39 percent reduction in emissions. All distillate oil boilers are already below the expected RACT limit (0.3 lb/MMBtu).

Oil, Tangential -- BOOS + FGR (at 42 percent control) was modeled to bring tangential boilers into compliance with RACT requirements. LNB (at 33 percent control) is sufficient for most boilers, but is more costly than BOOS + FGR. All distillate oil boilers are already below the RACT limit (0.2 lb/MMBtu).

Oil, Cyclone -- NGR (at a 53 percent reduction) is the only control technique available for application to cyclone boilers. According to the EPA/NESCAUM report, this technique is not well demonstrated and will probably not be commercially available. The Title I General Preamble does not include specific RACT limits for cyclone boilers.

Gas, Wall -- BOOS + FGR (at a 39 percent reduction) was estimated to achieve the necessary reductions for wall-fired natural gas units. This brings most units into compliance. Other controls that achieve necessary reductions for all units are more costly, therefore BOOS + FGR is modeled based on the assumption that other minor modifications in operation will probably bring the boilers into compliance with the standard.

Gas, Tangential -- BOOS is estimated to achieve the necessary reductions to meet RACT limits for gas-fired tangential utility boilers. The estimated efficiency used for modeling is 25 percent.

Gas, Cyclone -- NGR was applied at a 53 percent reduction. This is the only control technique available for cyclone boilers based on the EPA/NESCAUM report. Again, this technique is not well demonstrated. Specific RACT limits for cyclone boilers are not included in the Title I General Preamble.

5.3.2 NO_x RACT to 25 tpy

The controls modeled as RACT for the 100 tpy and above sources were also considered to be RACT for sources emitting 25 to 100 tpy under this scenario. Table 5-3 lists the RACT-level controls along with cost estimates for implementing the controls. RACT was applied to all boilers emitting above 25 tpy, rather than the 100 tpy RACT cutoff mandated for the OTR.

As shown in Table 5-4, lowering the RACT cutoff does not result in any incremental NO_x benefits beyond those achieved through Act-required measures. One reason for this is that utility units tend to be above the 100 tpy RACT cutoff. In addition, utilities may also be subject to Title IV limits. Lastly, the utility data base from the 1990 Interim Inventory was developed from fossil-fuel use data for plants of 10 MW or greater. It is difficult to quantify the potential NO_x emissions from smaller units because emissions depend on the fuel type, the boiler configuration, and the hours operated. Smaller units, however, tend to operate on oil or gas, which is less polluting than coal. The State inventories may include these smaller plants; however, the effect of extending RACT to these units is expected to be small. Because it is likely the smaller plants will operate on oil or gas, most will emit less than 50 tpy and many will be below the 25 tpy cutoff to which RACT was extended in this analysis.

5.3.3 More Stringent Control for Existing Major Sources

Selective catalytic reduction (SCR) was applied to all existing 100 tpy or greater utility boilers (except stokers and cyclones) under the more stringent control scenario. The estimated control efficiencies are shown in Table 5-3. NGR was applied to cyclone boilers, equivalent to what was assumed in modeling RACT-level controls. NGR is the only control technique applicable to cyclone boilers based on recent studies.

The emission reductions for applying more stringent controls on utility boilers vary significantly from area to area as shown in Table 5-4. The level of reductions achieved depends on the magnitude of emissions in the baseline (i.e., the number and size of boilers in each area) and the baseline emission level (lbs NO_x per MMBtu). Gas- and oil-fired units emit less to begin with, so corresponding reductions are lower. In areas where no reductions are observed, the units are either below the 100 tpy cutoff modeled or units are expected to be retired (and may be replaced by new units). Comparing these reductions to the Stage II reductions in Table 3-5 shows that more stringent controls on utility boilers would result in comparable reductions in most areas with existing utility units. Exceptions include those where very low incremental reductions are shown, including Knox and Lincoln Counties in Maine, and Atlantic City, New Jersey.

5.4 NON-UTILITY POINT SOURCE CONTROL MEASURES

Non-utility point sources examined in this analysis include industrial boilers, internal combustion engines, stationary gas turbines, process heaters, and acid manufacturing plants. As with the utility point source category, the alternative measures analyzed for non-utility point sources were lowering the NO_x RACT source size cutoff from 100 tpy to 25 tpy and requiring more stringent control for existing 100 tpy or greater sources.

5.4.1 Modeling Assumptions

Emissions were projected to future years by applying Bureau of Economic Analysis (BEA) earnings-based growth factors by two-digit SIC and State to the base year emission estimates. (See reference 23.) Ozone season daily emissions were calculated from the annual emissions by source category using operational data from the Interim Inventory. Default values of 52 operational weeks per year, 7 operational days per week, and a summer percentage throughput of 25 percent were used in cases where data were not available for ozone season calculations. The equations used to estimate ozone season daily emissions were as follows:

Ozone Season Weeks = Max (13, (Summer Throughput Percentage * Weeks per Year))

$$\text{Ozone Season Daily Emissions} = \frac{(NO_x \text{ Emissions} * \text{Summer Throughput Percentage})}{(\text{Ozone Season Weeks} * \text{Days per Week})}$$

The results of the control analysis are presented in Table 5-5. Detailed summaries by source category are provided in Appendix C.

Determining RACT Level and More Stringent Controls

NO_x RACT and more stringent control strategies and associated control costs are shown in Table 5-3 and described below. Control measure information for non-utility point sources was taken from the various EPA Alternative Control Technology Documents as cited under each source category described below. NO_x RACT to 100 tpy sources is required under Title I of the Act. The controls specified as RACT were applied to each individual source if it qualified as a major source and if the existing control level was lower than the RACT level.

1. *Industrial Boilers*

Pulverized Coal -- LNB was assumed as the RACT method of control for pulverized coal (PC)-fired industrial boilers. This control is expected to provide a NO_x reduction of 45 percent at an average cost per ton of $1,350. SCR was chosen as the more stringent control at an estimated 79 percent reduction in emissions $6,600 per ton reduced. (See reference 24.)

Stokers -- Because limited data were available on control techniques for stokers, the RACT and more stringent level of control were assumed to be the same. Selective non-catalytic reduction (SNCR) was the selected control technique, with a NO_x reduction of 55 percent and average default cost of $1,800 per ton. (See reference 24.)

Residual Oil, Distillate Oil, and Natural Gas -- RACT and more stringent control techniques for each of the three oil

Table 5-5. Non-Utility Control Measure Emission Reductions Projection Year 1999

	RACT to 25 tpy**		More Stringent Control to 100 tpy**	
Ozone Area*	NO_x (tpd)	Comparable VOC	NO_x (tpd)	Comparable VOC
Delaware				
Sussex County	0.38	0.95	1.05	2.63
Maine				
Hancock & Waldo Counties	0.45	0.50	0.26	0.29
Knox & Lincoln Counties	0.16	0.18	0.00	0.00
Lewiston-Auburn	0.30	0.43	0.00	0.00
Portland	0.31	0.34	0.49	0.54
Franklin County	0.00	0.00	0.84	0.53
Oxford County	0.00	0.00	0.23	0.29
Somerset County	0.34	0.34	0.17	0.17
Attainment Counties	1.07	1.19	1.77	1.97
Maryland				
Kent & Queen Anne's Counties	0.00	0.00	0.00	0.00
Attainment Counties	1.83	2.03	2.09	2.32
New Hampshire				
Manchester	0.10	0.08	0.00	0.00
Chesire County	0.00	0.00	0.00	0.00
Attainment Counties	0.25	0.28	0.63	0.70
New Jersey				
Allentown-Bethlehem-Easton	0.33	0.33	3.29	3.29
Atlantic City	0.29	0.22	0.00	0.00
New York				
Albany-Schenectady-Troy	1.80	2.57	0.94	1.34
Buffalo-Niagara Falls	1.44	1.44	1.27	1.27
Essex County	0.00	0.00	0.44	0.40
Jefferson County	0.30	0.38	0.21	0.26
Poughkeepsie	0.76	1.27	0.00	0.00
Attainment Counties	4.19	5.24	8.22	10.28
Pennsylvania				
Allentown-Bethlehem-Easton	0.17	0.15	0.00	0.00
Altoona	0.34	0.38	0.00	0.00
Erie	0.11	0.55	0.40	2.00
Harrisburg-Lebanon-Carlisle	0.44	0.55	0.00	0.00

Table 5-5 (continued)

Ozone Area*	RACT to 25 tpy**		More Stringent Control to 100 tpy**	
	NO_x (tpd)	Comparable VOC	NO_x (tpd)	Comparable VOC
Johnstown	0.81	1.01	0.03	0.04
Lancaster	0.20	0.29	1.32	1.89
Pittsburgh-Beaver Valley	3.40	2.27	7.92	5.28
Reading	1.05	1.17	0.00	0.00
Scranton-Wilkes-Barre	0.79	1.13	1.21	1.73
York	0.43	0.27	1.51	0.94
Youngstown-Warren-Sharon	0.56	0.62	1.20	1.33
Crawford County	0.00	0.00	0.30	0.43
Franklin County	0.07	0.10	0.00	0.00
Greene County	0.00	0.00	0.00	0.00
Lawrence County	0.00	0.00	0.00	0.00
Northumberland County	0.22	0.31	0.00	0.00
Pike County	0.07	0.23	0.00	0.00
Schuylkill County	0.07	0.10	0.00	0.00
Warren County	0.79	0.79	0.00	0.00
Attainment Counties	5.18	2.07	6.53	2.61
Vermont				
Attainment Counties	0.13	0.19	0.00	0.00

NOTES: *Areas not appearing in the table do not have non-utility point source NO_x emitters.

**Zeros indicate that additional reductions (above the Act) would not be achieved through the selected control measures.

and gas-fired boiler types were assumed to be the same. RACT control via LNB provides NO_x reductions of 50 percent, while SCR control (more stringent) reduces emissions by 80 percent for all sources. Costs per ton for these RACT controls average $620 for residual oil, $1,180 for distillate oil, and $770 for natural gas. Estimated average costs for SCR are $2,450 per ton reduced for residual oil, $3,950 for distillate oil, and $3,000 for boilers fired with natural gas. (See reference 24.)

2. *Internal Combustion Engines*

Natural Gas -- The RACT-level control technique chosen for natural gas-fired internal combustion (IC) engines is an AF ratio combustion modification coupled with an IR modification expected to provide an emissions reduction of 30 percent at an average cost of $551 per ton reduced. Low emission (L-E) combustion designs provide an emission reduction of 80 percent for the more stringent control technique at an average of $618 per ton reduced. (See reference 25.)

Oil -- The ignition timing retardation (IR) method of emissions control was used in determining RACT reductions for oil fired IC engines. The associated NO_x reduction is 25 percent and costs an average of $518 per ton of NO_x reduced. SCR (more stringent control) is estimated to reduce NO_x emissions by 80 percent, costing an average of $1,540 per ton of NO_x reduced. (See reference 25.)

3. *Gas Turbines*

Natural Gas -- A LNB control method was chosen to reflect RACT-level controls for natural gas-fired turbines with an average default cost per ton of $236 and an emissions reduction of 84 percent. SCR control in addition to a steam injection system is estimated to reduce emissions by up to 95 percent, while costing $5,581 per ton of NO_x reduced. (See reference 26.)

Oil -- RACT control was chosen to be a water injection system that reduces NO_x emissions by 70 percent from uncontrolled rates. This control technique costs an average of $1,166 per ton of NO_x reduced. The water injection system, coupled with SCR, was selected as the more stringent control option and is estimated to reduce emissions by 94 percent, costing an average of $2,835 per ton reduced. (See reference 26.)

4. Process Heaters

Natural Gas -- ULNB was utilized to reduce NO_x emissions by 75 percent in the natural gas-fired process heaters. These reductions cost an average of $532 per ton NO_x reduced. A combination of LNB and SCR controls reduced emissions by 88 percent, costing $3,905 per ton reduced. (See reference 27.)

Distillate Oil -- ULNB was chosen for RACT control, reducing emissions by 74 percent, but with a slightly higher cost than with gas-firing, at $735 per ton reduced. The more stringent control option was estimated as the LNB + SCR combination, reducing NO_x emissions by 92 percent and costing an average of $6,340 per ton reduced in distillate oil fired heaters. (See reference 27.)

Residual Oil -- The ULNB and LNB + SCR methods of control were again chosen to represent RACT and the more stringent control option for residual oil-fired process heaters, with emissions reductions of 73 percent and 91 percent, and average NO_x control costs of $442 and $3,820 per ton, respectively. (See reference 27.)

5. Acid Manufacturing Plants

Adipic Acid -- Both the RACT and more stringent control methods assumed were thermal reduction control in adipic acid manufacturing plants. Very little data were available for these plants, but reductions of 81 percent were reported at an average cost of $460 per ton. (See reference 28.)

Nitric Acid -- A method of extended absorption was chosen for RACT control in the nitric acid manufacturing plants. This method reduces NO_x emissions by 95 percent and costs an average of $173 per ton reduced compared with the 98 percent reduction and $600 per ton reduced listed for the more stringent control technique of NSCR. (See reference 28.)

5.4.2 NO_x RACT to 25 tpy Sources

The incremental effect of applying RACT to 25 tpy sources was examined by comparing this scenario with the baseline (the Act) scenario. The results of this analysis are shown in Table 5-5 for projection year 1999. Because the point source inventory does not provide complete coverage of sources below 50 tpy for NO_x (sources less than 50 tpy would only appear if they are considered major for one of the other criteria pollutants), the effect of applying NO_x RACT to 25 tpy is expected to be underestimated. The magnitude of the emission reductions vary by area depending on the mix of sources in the individual areas. Comparing the reductions with the Stage II reductions in Table 3-5 shows comparable reductions for NO_x RACT to 25 tpy in Sussex County in Delaware, Hancock/Waldo and Somerset counties in Maine, Poughkeepsie in New York, Johnstown, Reading, Youngstown-Warren-Sharon, Northumberland County, Pike County, and Warren County in Pennsylvania. For some areas, such as Sussex County in Delaware and Poughkeepsie in New York, the low NO_x to VOC ratio contributes to the comparability.

5.4.3 More Stringent NO_x Control to 100 tpy Sources

The incremental effects of applying more stringent controls on NO_x sources was examined by applying the control levels discussed above and comparing this scenario with the baseline control (the Act) scenario. These results are also shown in Table 5-5. The reductions achieved depend on the mix of sources within the area. Several areas show reductions comparable to Stage II for more stringent NO_x controls. Areas that do not show comparable reductions are those where reductions are zero (either no sources are above 100 tpy or more stringent control options are not available for the types of sources in the area), areas with high NO_x to VOC substitution ratios, such as the attainment counties in Pennsylvania, and other areas where the NO_x reductions are low due to the mix of sources. Detailed results by source category are provided in Appendix C.

6.0 CONDUCTING AN INDEPENDENT COMPARABILITY ANALYSIS

States have the option of conducting an independent comparability analysis to re-examine measures covered in this report using up-to-date, State-specific information or to evaluate control measures not included in this report. This chapter describes the method that States may use for the analysis. Included are procedures for determining the emission reductions achieved by Stage II controls and the emission reductions associated with alternative measures the State is considering to adopt as comparable to Stage II.

6.1 COMPARABILITY DEMONSTRATIONS

To be comparable, the emissions reductions achievable through the alternative measures must equal or exceed those achievable by Stage II at projection year 1999. As discussed in Chapter 2, States have some flexibility with regard to certain aspects of their comparability determination. These items are summarized below.

- Both single measures and combinations of measures may be considered as potential comparable measures.
- States may adopt comparable NO_x control measures instead of Stage II.
- VOC and NO_x emissions reductions from an alternative measure may be summed (in the manner described in Chapter 5).
- Measures may be shown to be comparable on an individual ozone area basis or on an aggregate basis for affected areas in the State.

Consistent data sets should be used to demonstrate comparability. If the State elects to use its own 1990 base year inventory instead of the 1990 Interim Inventory to project emissions reductions for comparable measures, then to maintain consistency, the entire demonstration should be made using the State's inventory. Likewise, if the State uses its own inventory to estimate reductions due to Stage II vapor recovery, then the emission reductions associated with comparable measures should also be estimated using the State inventory.

States may wish to substitute their own growth or control information for the data used in this analysis. The EPA recognizes that complete State inventories may not be available for all areas covered under this study. States may therefore use the Interim Inventory as the basis for demonstrating comparability of measures, substituting State-specific growth or control assumptions. The Interim Inventory may also be used to demonstrate the comparability of other measures not examined in this study.

The States will have the responsibility to adequately document the following: 1) the 1990 base year inventory for all source categories affected by control measures used to demonstrate comparability; 2) the growth factors used to project emissions to 1999; 3) control measure assumptions for the baseline (including Act-required measures) projection and the control strategy (potential comparable measures) projection; 4) information on how the MOBILE5 model was run; 5) the expected emissions reductions for Stage II and the comparable measures; and 6) the equivalency of NO_x reductions to VOC reductions (if NO_x control measures are used).

6.2 DETERMINING STAGE II EMISSIONS REDUCTIONS

In a State's own comparability analysis, the Stage II emission reduction estimates may be taken directly from this report or the State may utilize its own data to estimate VOC emissions reductions attributable to Stage II. If a State chooses to use its own data, the following information and documentation should be provided:

- Base year (1990) vehicle refueling emissions and emission calculations -- States should follow SIP emission inventory guidance and follow EPA-approved methods for calculating base year emissions. The recommended method is to apply MOBILE5a emission factors (in grams per gallon) to estimated gasoline consumption. Alternatively, VMT-based emission factors may be used. If the State uses the Interim Inventory as the basis for projections, documentation is limited to simply stating so.

- Growth factors (and documentation if factors other than BEA or E-GAS are used) for projecting activity to 1999. If BEA or E-GAS (EPA-recommended sources) are used, documentation is limited to simply stating this; otherwise, documentation should be sufficient for EPA to duplicate calculations and make a judgment as to the acceptability of the growth factors.

- MOBILE5a emission factors and input files for the 1999 baseline scenario that includes mandatory controls but not Stage II -- Mandatory controls affecting refueling emissions include phase II RVP and ORVR controls (discussed below).

- MOBILE5a emission factors and input files for the 1999 scenario, with Stage II.

- 1999 projection year refueling emissions without Stage II.

- 1999 projection year refueling emissions after Stage II controls are applied.

- Stage II emission reduction estimates for the projection year.

Emission reductions for Stage II should be measured from a future year baseline which includes the effects of ORVR. ORVR controls should be modeled beginning in model year 1999 for LDGV (because MOBILE5a does not model phase-in for ORVR).

6.3 DETERMINING EMISSIONS REDUCTIONS FROM ALTERNATIVE MEASURES

As stated previously, States may re-examine measures covered in this report or evaluate measures not covered by this report. In either case, the State should clearly define the particular measure(s) and document the methods used to estimate emissions reductions from implementation of the measures. At a minimum, the following information should be submitted:

- Base year emissions and calculations for the source category(s) affected -- States should follow EPA guidance on the development of SIP inventories when preparing base year emission estimates. Alternatively, the State may use the Interim Inventory for the base year emissions. The data selected should be consistent with the emissions data used to estimate Stage II emissions reductions.

- Growth factors for projecting emissions to 1999. If BEA or E-GAS (EPA-recommended sources) are used, documentation is limited to simply stating this; otherwise, documentation should be sufficient for EPA to duplicate calculations and make a judgment as to the acceptability of the growth factors.

- Control assumptions for the baseline controls, including the emission factors, control efficiency, rule effectiveness, and rule penetration for each source category. Documentation of MOBILE5a input should be provided if motor vehicle measures are included.

- Control assumptions for the control strategy (comparable measure) projection, including the emission factor, control efficiency, rule effectiveness, and rule penetration for each source category. Documentation of MOBILE5a input should be provided if motor vehicle measures are included.

- 1999 projection year emissions by source category under the mandatory Act requirements.
- 1999 projection year emissions by source category after application of comparable measures.
- Estimated emissions reductions for comparable measures calculated using the two projections above.
- Calculation of VOC comparable emissions if a NO_x control measure is being substituted for Stage II. The method for substituting NO_x for VOC is given in Chapter 5 of this report. If the State uses its own inventory data, then complete VOC and NO_x inventories should be provided in order to show equivalency of NO_x measures on a percent of inventory basis.

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APPENDIX A

OZONE NONATTAINMENT CLASSIFICATIONS

Table A-1. Ozone Nonattainment Classifications

Area Classification	Design Value* (parts per million)
Marginal	0.121 up to 0.138
Moderate	0.138 up to 0.160
Serious	0.160 up to 0.180
Severe-15	0.180 up to 0.190
Severe-17	0.190 up to 0.280
Extreme	0.280 and above

Submarginal - areas that violated the ozone standard during 1987-1989 but had a design value during the period of less than 0.121 ppm (the lower limit for marginal areas) due to adjustment for missing data when calculating expected exceedances.

Transitional - areas designated nonattainment by operation of law which did not violate the NAAQS for ozone during the 1987-1989 period.

Incomplete data areas - ozone areas designated nonattainment prior to enactment which did not have sufficient air quality monitoring data to determine whether they were or were not violating the NAAQS.

*EPA used 1987-89 as the primary data years in determining designations and classifications for ozone areas set forth in the final rule on Air Quality Designations and Classifications (56FR56694, November 6, 1991).

APPENDIX B

VOC EMISSION REDUCTION SUMMARIES BY SOURCE CATEGORY

Table B-1. Stationary Source VOC Control Measure Emission Reductions by Source Category Projection Year 1999

State	Ozone Area	VOC Reductions (tpd)*
Delaware		
	Sussex County	
	Dry cleaning	0.07
	Bakeries	0.00
	SOCMI fugitives	0.07
	Pharmaceutical	0.02
	manufacture	**0.17**
	Ozone Area Total	
Maine		
	Hancock & Waldo Counties	
	Dry cleaning	0.05
	Ozone Area Total	**0.05**
	Knox & Lincoln Counties	
	Dry cleaning	0.03
	Bakeries	0.00
	Ozone Area Total	**0.03**
	Lewiston-Auburn	
	Dry cleaning	0.15
	Bakeries	0.42
	Ozone Area Total	0.56
	Portland	
	Dry cleaning	0.47
	Bakeries	0.32
	Ozone Area Total	0.79
	Franklin County	
	Dry cleaning	0.00
	Ozone Area Total	**0.00**
	Oxford County	
	Dry cleaning	0.01
	Ozone Area Total	0.01
	Somerset County	
	Dry cleaning	0.01
	Ozone Area Total	**0.01**
	Attainment Counties	
	Dry cleaning	0.15
	Bakeries	0.10
	Ozone Area Total	0.25

Table B-1 (continued)

State	Ozone Area	VOC Reductions (tpd)*
Maryland		
	Kent & Queen Anne's Counties	
	Dry cleaning	0.03
	SOCMI fugitives	0.04
	Ozone Area Total	**0.07**
	Attainment Counties	
	Dry cleaning	0.33
	Bakeries	0.18
	Pharmaceutical manufacture	0.00
	Ozone Area Total	**0.52**
New Hampshire		
	Manchester	
	Dry cleaning	0.72
	Bakeries	0.05
	SOCMI fugitives	0.28
	Ozone Area Total	**1.05**
	Belknap County	
	Dry cleaning	0.03
	Bakeries	0.00
	Ozone Area Total	0.03
	Chesire County	
	Dry cleaning	0.09
	Ozone Area Total	0.09
	Sullivan County	
	Dry cleaning	0.01
	Bakeries	0.00
	Ozone Area Total	0.01
	Attainment Counties	
	Dry cleaning	0.10
	Pharmaceutical manufacture	0.00
	Ozone Area Total	0.10
New Jersey		
	Allentown-Bethlehem-Easton	
	Dry cleaning	0.07
	SOCMI fugitives	0.02
	Pharmaceutical manufacture	0.00
	Ozone Area Total	0.09

Table B-1 (continued)

State	Ozone Area		VOC Reductions (tpd)*
	Atlantic City		
		Dry cleaning	0.10
		Bakeries	0.16
		Pharmaceutical	0.10
		manufacture	**0.36**
		Ozone Area Total	
New York			
	Albany-Schenectady-Troy		
		Dry cleaning	0.69
		Bakeries	0.31
		Pharmaceutical	0.06
		manufacture	**1.07**
		Ozone Area Total	
	Buffalo-Niagara Falls		
		Dry cleaning	0.69
		Bakeries	0.53
		SOCMI fugitives	0.49
		Pharmaceutical	0.12
		manufacture	1.82
		Ozone Area Total	
	Essex County		
		Dry cleaning	0.00
		Ozone Area Total	**0.00**
	Jefferson County		
		Dry cleaning	0.07
		Bakeries	0.00
		Ozone Area Total	**0.07**
	Poughkeepsie		
		Dry cleaning	0.12
		Bakeries	0.02
		Ozone Area Total	**0.14**
	Attainment Counties		
		Dry cleaning	3.14
		Bakeries	0.79
		SOCMI fugitives	0.26
		Pharmaceutical	0.76
		manufacture	**4.95**
		Ozone Area Total	

Table B-1 (continued)

State	Ozone Area	VOC Reductions (tpd)*
Pennsylvania		
	Allentown-Bethlehem-Easton	
	Dry cleaning	0.35
	Bakeries	0.23
	SOCMI fugitives	0.11
	Pharmaceutical manufacture	0.01
	Ozone Area Total	**0.69**
	Altoona	
	Dry cleaning	0.06
	Bakeries	0.13
	Ozone Area Total	**0.19**
	Erie	
	Dry cleaning	0.22
	Bakeries	0.08
	Pharmaceutical manufacture	0.00
	Ozone Area Total	**0.30**
	Harrisburg-Lebanon-Carlisle	
	Dry cleaning	0.29
	Bakeries	0.32
	Pharmaceutical manufacture	0.05
	Ozone Area Total	0.66
	Johnstown	
	Dry cleaning	0.05
	Bakeries	0.05
	SOCMI fugitives	0.02
	Ozone Area Total	**0.12**
	Lancaster	
	Dry cleaning	0.18
	Bakeries	0.30
	Pharmaceutical manufacture	0.15
	Ozone Area Total	**0.63**
	Pittsburgh-Beaver Valley	
	Dry cleaning	1.60
	Bakeries	0.99
	SOCMI fugitives	0.79
	Pharmaceutical manufacture	0.10
	Ozone Area Total	3.48

Table B-1 (continued)

State	Ozone Area	VOC Reductions (tpd)*
	Reading	
	Dry cleaning	0.29
	Bakeries	0.50
	Pharmaceutical manufacture	0.00
	Ozone Area Total	**0.79**
	Scranton-Wilkes-Barre	
	Dry cleaning	0.43
	Bakeries	0.18
	Pharmaceutical manufacture	0.00
	Ozone Area Total	**0.61**
	York	
	Dry cleaning	0.41
	Bakeries	0.31
	Ozone Area Total	**0.72**
	Youngstown-Warren-Sharon	
	Dry cleaning	0.05
	Bakeries	0.10
	Ozone Area Total	**0.16**
	Crawford County	
	Dry cleaning	0.04
	Bakeries	0.01
	Pharmaceutical manufacture	0.17
	Ozone Area Total	**0.22**
	Franklin County	
	Dry cleaning	0.04
	Ozone Area Total	**0.04**
	Greene County	
	Dry cleaning	0.02
	Ozone Area Total	**0.02**
	Juniata County	
	Dry cleaning	0.00
	Ozone Area Total	0.00
	Lawrence County	
	Dry cleaning	0.02
	Ozone Area Total	**0.02**
	Northumberland County	
	Dry cleaning	0.00
	Bakeries	0.17
	Ozone Area Total	**0.17**

Table B-1 (continued)

State	Ozone Area	VOC Reductions (tpd)*
	Pike County	
	Dry cleaning	0.02
	Ozone Area Total	**0.02**
	Schuylkill County	
	Dry cleaning	0.02
	Bakeries	0.03
	Ozone Area Total	**0.05**
	Snyder County	
	Dry cleaning	0.02
	Ozone Area Total	**0.02**
	Susquehanna County	
	Dry cleaning	0.00
	Ozone Area Total	**0.00**
	Warren County	
	Dry cleaning	0.02
	Ozone Area Total	**0.02**
	Wayne County	
	Dry cleaning	0.01
	Ozone Area Total	**0.01**
	Attainment Counties	
	Dry cleaning	0.25
	Bakeries	0.39
	SOCMI fugitives	0.17
	Ozone Area Total	**0.81**
Vermont		
	Attainment Counties	
	Dry cleaning	0.57
	Bakeries	0.20
	Pharmaceutical	0.00
	manufacture	**0.77**
	Ozone Area Total	

*NOTE: *Zeros indicate that reductions are less than 0.01 tpd. If a source category is not listed for the area, emissions for that source category are zero.

APPENDIX C

NO_x EMISSION REDUCTION SUMMARIES BY SOURCE CATEGORY

Table C-1. Utility Control Measure Emission Reductions by Source Category Projection Year 1999

State	Ozone Area*	NO_x Reductions (tpd) RACT** to 25 tpy	NO_x Reductions (tpd) More Stringent Control** to 100 tpy
Delaware			
	Sussex County		
	Utility Boiler - Pulverized Coal: Wall/Opposed	0.00	21.40
	Utility - Pulverized Coal: Tangential	0.00	0.00
	Ozone Area Total	**0.00**	**21.40**
Maine			
	Knox & Lincoln Counties		
	Utility Boiler - Pulverized Coal: Wall/Opposed	0.00	0.03
	Ozone Area Total	**0.00**	**0.03**
	Portland		
	Utility Boiler - Pulverized Coal: Wall/Opposed	0.00	4.57
	Utility - Pulverized Coal: Tangential	0.00	0.51
	Ozone Area Total	**0.00**	**5.08**
	Attainment Counties		
	Utility Boiler - Pulverized Coal: Wall/Opposed	0.00	0.00
	Ozone Area Total	**0.00**	**0.00**
Maryland			
	Attainment Counties		
	Utility Boiler - Pulverized Coal: Wall/Opposed	0.00	2.45
	Utility - Pulverized Coal: Tangential	0.00	2.81
	Ozone Area Total	**0.00**	**5.27**
New Hampshire			
	Manchester		
	Utility - Pulverized Coal: Tangential	0.00	0.00
	Utility Boiler - Gas	0.00	0.00
	Ozone Area Total	**0.00**	**0.00**
New Jersey			
	Atlantic City		
	Utility - Pulverized Coal: Tangential	0.00	1.09
	Utility Boiler - Gas	0.00	0.00
	Ozone Area Total	**0.00**	**1.09**
New York			
	Albany-Schenectady-Troy		
	Utility - Pulverized Coal: Tangential	0.00	8.37
	Ozone Area Total	**0.00**	**8.37**
	Buffalo-Niagara Falls		
	Utility Boiler - Pulverized Coal: Wall/Opposed	0.00	33.32
	Utility - Pulverized Coal: Tangential	0.00	10.35
	Ozone Area Total	**0.00**	**43.67**

Table C-1 (continued)

State	Ozone Area*	NO$_x$ Reductions (tpd) RACT** to 25 tpy	More Stringent Control** to 100 tpy
Pennsylvania			
	Attainment Counties		
	Utility Boiler - Pulverized Coal: Wall/Opposed	0.00	21.31
	Utility - Pulverized Coal: Tangential	0.00	35.87
	Ozone Area Total	**0.00**	**57.18**
	Allentown-Bethlehem-Easton		
	Utility Boiler - Pulverized Coal: Wall/Opposed	0.00	8.21
	Utility - Pulverized Coal: Tangential	0.00	17.61
	Ozone Area Total	**0.00**	**25.82**
	Altoona		
	Utility Boiler - Pulverized Coal: Wall/Opposed	0.00	0.00
	Utility - Pulverized Coal: Tangential	0.00	0.00
	Ozone Area Total	**0.00**	**0.00**
	Erie		
	Utility Boiler - Pulverized Coal: Wall/Opposed	0.00	1.11
	Utility - Pulverized Coal: Tangential	0.00	2.81
	Ozone Area Total	**0.00**	**3.92**
	Lancaster		
	Utility Boiler - Pulverized Coal: Wall/Opposed	0.00	0.00
	Utility - Pulverized Coal: Tangential	0.00	0.00
	Ozone Area Total	**0.00**	**0.00**
	Pittsburgh-Beaver Valley		
	Utility Boiler - Pulverized Coal: Wall/Opposed	0.00	102.40
	Utility - Pulverized Coal: Tangential	0.00	81.33
	Ozone Area Total	**0.00**	**183.73**
	Reading		
	Utility - Pulverized Coal: Tangential	0.00	6.14
	Ozone Area Total	**0.00**	**6.14**
	Scranton-Wilkes-Barre		
	Utility Boiler - Pulverized Coal: Wall/Opposed	0.00	0.00
	Utility - Pulverized Coal: Tangential	0.00	0.00
	Ozone Area Total	**0.00**	**0.00**
	York		
	Utility - Pulverized Coal: Tangential	0.00	45.67
	Ozone Area Total	**0.00**	**45.67**
	Greene County		
	Utility Boiler - Pulverized Coal: Wall/Opposed	0.00	45.70
	Utility - Pulverized Coal: Tangential	0.00	0.24
	Ozone Area Total	**0.00**	**45.94**
	Lawrence County		
	Utility Boiler - Pulverized Coal: Wall/Opposed	0.00	11.28
	Utility - Pulverized Coal: Tangential	0.00	0.00
	Ozone Area Total	**0.00**	**11.28**

Table C-1 (continued)

State	Ozone Area*	NO$_x$ Reductions (tpd)	
		RACT** to 25 tpy	More Stringent Control** to 100 tpy
Pennsylvania			
	Snyder County		
	Utility Boiler - Pulverized Coal: Wall/Opposed	0.00	14.79
	Utility - Pulverized Coal: Tangential	0.00	0.00
	Ozone Area Total	**0.00**	**14.79**
	Warren County		
	Utility Boiler - Pulverized Coal: Wall/Opposed	0.00	0.00
	Utility - Pulverized Coal: Tangential	0.00	0.00
	Ozone Area Total	**0.00**	**0.00**
	Attainment Counties		
	Utility Boiler - Pulverized Coal: Wall/Opposed	0.00	61.68
	Utility - Pulverized Coal: Tangential	0.00	117.71
	Ozone Area Total	**0.00**	**179.39**
Vermont			
	Attainment Counties		
	Utility Boiler - Pulverized Coal: Wall/Opposed	0.00	0.00
	Ozone Area Total	**0.00**	**0.00**

NOTES: *Areas not listed on the table do not have existing utility boilers.
**Zeros indicate that no additional reductions are achieved incremental to mandatory Act requirements.

Table C-2. Non-Utility Control Measure Emission Reductions by Source Category Projection Year 1999

State	Ozone Area*	NO_x Reductions (tpd)	
		RACT** to 25 tpy	More Stringent Control** to 100 tpy
Delaware			
	Sussex County		
	Industrial Boiler - Pulverized Coal	0.00	0.97
	Industrial Boiler - Stoker	0.05	0.00
	Industrial Boiler - Residual Oil	0.00	0.09
	Industrial Boiler - Distillate Oil	0.00	0.00
	Process Heaters - Oil	0.33	0.00
	Ozone Area Total	**0.38**	**1.05**
Maine			
	Hancock & Waldo Counties		
	Industrial Boiler - Stoker	0.00	0.00
	Industrial Boiler - Residual Oil	0.45	0.26
	Ozone Area Total	**0.45**	**0.26**
	Knox & Lincoln Counties		
	Industrial Boiler - Residual Oil	0.16	0.00
	Ozone Area Total	**0.16**	**0.00**
	Lewiston-Auburn		
	Industrial Boiler - Residual Oil	0.30	0.00
	Ozone Area Total	**0.30**	**0.00**
	Portland		
	Industrial Boiler - Pulverized Coal	0.00	0.49
	Industrial Boiler - Residual Oil	0.31	0.00
	Industrial Boiler - Distillate Oil	0.00	0.00
	Industrial Boiler - Natural Gas	0.00	0.00
	Ozone Area Total	**0.31**	**0.49**
	Franklin County		
	Industrial Boiler - Residual Oil	0.00	0.84
	Ozone Area Total	**0.00**	**0.84**
	Oxford County		
	Industrial Boiler - Residual Oil	0.00	0.23
	Industrial Boiler - Distillate Oil	0.00	0.00
	Ozone Area Total	**0.00**	**0.23**
	Somerset County		
	Industrial Boiler - Residual Oil	0.34	0.17
	Industrial Boiler - Distillate Oil	0.00	0.00
	Ozone Area Total	**0.34**	**0.17**
	Attainment Counties		
	Industrial Boiler - Stoker	0.13	0.00
	Industrial Boiler - Residual Oil	0.94	1.77
	Industrial Boiler - Distillate Oil	0.00	0.00
	Ozone Area Total	**1.07**	**1.77**

Table C-2 (continued)

State	Ozone Area*	NO_x Reductions (tpd) RACT** to 25 tpy	More Stringent Control** to 100 tpy
Maryland			
	Kent & Queen Anne's Counties		
	Industrial Boiler - Residual Oil	0.00	0.00
	Industrial Boiler - Natural Gas	0.00	0.00
	Industrial Boilers - Other Oil/Gas	0.00	0.00
	Ozone Area Total	**0.00**	**0.00**
	Attainment Counties		
	Utility Boiler - Gas	0.00	0.00
	Industrial Boiler - Pulverized Coal	0.09	1.31
	Industrial Boiler - Stoker	0.21	0.00
	Industrial Boiler - Residual Oil	0.54	0.00
	Industrial Boiler - Distillate Oil	0.00	0.00
	Industrial Boiler - Natural Gas	0.19	0.00
	Internal Combustion Engines - Oil	0.80	0.78
	Gas Turbines - Oil Fired	0.00	0.00
	Ozone Area Total	**1.83**	**2.09**
New Hampshire			
	Manchester		
	Industrial Boiler - Residual Oil	0.10	0.00
	Industrial Boiler - Natural Gas	0.00	0.00
	Ozone Area Total	**0.10**	**0.00**
	Chesire County		
	Industrial Boiler - Residual Oil	0.00	0.00
	Ozone Area Total	**0.00**	**0.00**
	Attainment Counties		
	Industrial Boiler - Residual Oil	0.25	0.63
	Ozone Area Total	**0.25**	**0.63**
New Jersey			
	Allentown-Bethlehem-Easton		
	Industrial Boiler - Residual Oil	0.33	0.15
	Internal Combustion Engines - Oil	0.00	3.14
	Ozone Area Total	**0.33**	**3.29**
	Atlantic City		
	Industrial Boiler - Residual Oil	0.00	0.00
	Internal Combustion Engines - Oil	0.00	0.00
	Gas Turbines - Oil Fired	0.29	0.00
	Ozone Area Total	**0.29**	**0.00**
New York			
	Albany-Schenectady-Troy		
	Industrial Boiler - Stoker	0.06	0.00
	Industrial Boiler - Residual Oil	1.03	0.66
	Industrial Boiler - Distillate Oil	0.00	0.00
	Industrial Boiler - Natural Gas	0.71	0.28
	Ozone Area Total	**1.80**	**0.94**

Table C-2 (continued)

State	Ozone Area*	NO$_x$ Reductions (tpd) RACT** to 25 tpy	More Stringent Control** to 100 tpy
New York			
	Buffalo-Niagara Falls		
	Industrial Boiler - Pulverized Coal	0.00	0.35
	Industrial Boiler - Stoker	0.43	0.00
	Industrial Boiler - Residual Oil	0.82	0.50
	Industrial Boiler - Natural Gas	0.19	0.43
	Ozone Area Total	**1.44**	**1.27**
	Essex County		
	Industrial Boiler - Residual Oil	0.00	0.44
	Ozone Area Total	**0.00**	**0.44**
	Jefferson County		
	Industrial Boiler - Pulverized Coal	0.00	0.21
	Industrial Boiler - Stoker	0.22	0.00
	Industrial Boiler - Residual Oil	0.08	0.00
	Industrial Boiler - Distillate Oil	0.00	0.00
	Ozone Area Total	**0.30**	**0.21**
	Poughkeepsie		
	Industrial Boiler - Stoker	0.00	0.00
	Industrial Boiler - Residual Oil	0.76	0.00
	Industrial Boiler - Distillate Oil	0.00	0.00
	Industrial Boiler - Natural Gas	0.00	0.00
	Ozone Area Total	**0.76**	0.00
	Attainment Counties		
	Utility Boiler - Gas	0.00	0.00
	Industrial Boiler - Pulverized Coal	0.00	2.83
	Industrial Boiler - Stoker	0.88	0.00
	Industrial Boiler - Residual Oil	2.41	5.22
	Industrial Boiler - Distillate Oil	0.00	0.00
	Industrial Boiler - Natural Gas	0.90	0.17
	Ozone Area Total	**4.19**	**8.22**
Pennsylvania			
	Allentown-Bethlehem-Easton		
	Industrial Boiler - Residual Oil	0.00	0.00
	Industrial Boiler - Distillate Oil	0.00	0.00
	Industrial Boiler - Natural Gas	0.17	0.00
	Ozone Area Total	**0.17**	**0.00**
	Altoona		
	Industrial Boiler - Stoker	0.34	0.00
	Industrial Boiler - Residual Oil	0.00	0.00
	Industrial Boiler - Distillate Oil	0.00	0.00
	Ozone Area Total	**0.34**	**0.00**

Table C-2 (continued)

State	Ozone Area*	NO_x Reductions (tpd) RACT** to 25 tpy	More Stringent Control** to 100 tpy
Pennsylvania			
	Erie		
	Utility Boiler - Gas	0.00	0.00
	Industrial Boiler - Pulverized Coal	0.00	0.40
	Industrial Boiler - Stoker	0.11	0.00
	Industrial Boiler - Natural Gas	0.00	0.00
	Ozone Area Total	**0.11**	**0.40**
	Harrisburg-Lebanon-Carlisle		
	Industrial Boiler - Pulverized Coal	0.00	0.00
	Industrial Boiler - Stoker	0.06	0.00
	Industrial Boiler - Residual Oil	0.06	0.00
	Gas Turbines - Natural Gas	0.32	0.00
	Ozone Area Total	**0.44**	**0.00**
	Johnstown		
	Industrial Boiler - Stoker	0.00	0.00
	Industrial Boiler - Distillate Oil	0.00	0.00
	Industrial Boiler - Natural Gas	0.29	0.00
	Internal Combustion Engines - Natural Gas	0.20	0.00
	Gas Turbines - Natural Gas	0.32	0.03
	Ozone Area Total	**0.81**	**0.03**
	Lancaster		
	Industrial Boiler - Stoker	0.20	0.00
	Internal Combustion Engines - Natural Gas	0.00	1.32
	Ozone Area Total	**0.20**	**1.32**
	Pittsburgh-Beaver Valley		
	Industrial Boiler - Pulverized Coal	0.13	3.60
	Industrial Boiler - Stoker	1.53	0.00
	Industrial Boiler - Residual Oil	0.12	0.00
	Industrial Boiler - Distillate Oil	0.00	0.00
	Industrial Boiler - Natural Gas	1.13	0.10
	Internal Combustion Engines - Natural Gas	0.49	3.99
	Gas Turbines - Natural Gas	0.00	0.04
	Industrial Boilers - Other Coal	0.00	0.20
	Ozone Area Total	**3.40**	**7.92**
	Reading		
	Industrial Boiler - Stoker	0.00	0.00
	Industrial Boiler - Residual Oil	0.24	0.00
	Industrial Boiler - Distillate Oil	0.00	0.00
	Industrial Boiler - Natural Gas	0.00	0.00
	Gas Turbines - Natural Gas	0.81	0.00
	Gas Turbines - Oil Fired	0.00	0.00
	Ozone Area Total	**1.05**	**0.00**

Table C-2 (continued)

State	Ozone Area*	NO$_x$ Reductions (tpd) RACT** to 25 tpy	More Stringent Control** to 100 tpy
Pennsylvania			
	Scranton-Wilkes-Barre		
	Industrial Boiler - Pulverized Coal	0.32	0.00
	Industrial Boiler - Stoker	0.20	0.00
	Industrial Boiler - Residual Oil	0.23	0.00
	Industrial Boiler - Distillate Oil	0.00	0.00
	Industrial Boiler - Natural Gas	0.04	0.00
	Internal Combustion Engines - Natural Gas	0.00	1.21
	Ozone Area Total	**0.79**	**1.21**
	York		
	Industrial Boiler - Pulverized Coal	0.00	1.10
	Industrial Boiler - Stoker	0.11	0.00
	Industrial Boiler - Residual Oil	0.00	0.00
	Industrial Boiler - Distillate Oil	0.00	0.00
	Industrial Boiler - Natural Gas	0.32	0.00
	Internal Combustion Engines - Natural Gas	0.00	0.41
	Ozone Area Total	**0.43**	**1.51**
	Youngstown-Warren-Sharon		
	Industrial Boiler - Natural Gas	0.35	0.24
	Internal Combustion Engines - Natural Gas	0.21	0.96
	Ozone Area Total	**0.56**	**1.20**
	Crawford County		
	Industrial Boiler - Pulverized Coal	0.00	0.30
	Ozone Area Total	**0.00**	**0.30**
	Franklin County		
	Industrial Boiler - Stoker	0.07	0.00
	Industrial Boiler - Residual Oil	0.00	0.00
	Ozone Area Total	**0.07**	**0.00**
	Lawrence County		
	Industrial Boiler - Stoker	0.00	0.00
	Ozone Area Total	**0.00**	**0.00**
	Northumberland County		
	Industrial Boiler - Stoker	0.17	0.00
	Industrial Boiler - Distillate Oil	0.00	0.00
	Industrial Boiler - Natural Gas	0.05	0.00
	Ozone Area Total	**0.22**	**0.00**
	Pike County		
	Industrial Boiler - Residual Oil	0.07	0.00
	Ozone Area Total	**0.07**	**0.00**
	Schuylkill County		
	Industrial Boiler - Stoker	0.07	0.00
	Industrial Boiler - Residual Oil	0.00	0.00
	Ozone Area Total	**0.07**	**0.00**

Table C-2 (continued)

State	Ozone Area*	NO_x Reductions (tpd) RACT** to 25 tpy	More Stringent Control** to 100 tpy
Pennsylvania			
	Warren County		
	Industrial Boiler - Stoker	0.12	0.00
	Industrial Boiler - Residual Oil	0.00	0.00
	Industrial Boiler - Natural Gas	0.28	0.00
	Process Heaters - Natural Gas	0.30	0.00
	Process Heaters - Oil	0.08	0.00
	Ozone Area Total	**0.79**	**0.00**
	Attainment Counties		
	Industrial Boiler - Pulverized Coal	0.07	0.74
	Industrial Boiler - Stoker	1.35	0.00
	Industrial Boiler - Residual Oil	0.00	0.12
	Industrial Boiler - Distillate Oil	0.00	0.00
	Industrial Boiler - Natural Gas	0.05	0.00
	Internal Combustion Engines - Natural Gas	3.72	5.67
	Process Heaters - Natural Gas	0.00	0.00
	Process Heaters - Oil	0.00	0.00
	Ozone Area Total	**5.18**	**6.53**
Vermont			
	Attainment Counties		
	Industrial Boiler - Stoker	0.00	0.00
	Industrial Boiler - Residual Oil	0.13	0.00
	Gas Turbines - Oil Fired	0.00	0.00
	Ozone Area Total	**0.13**	**0.00**

NOTES: *Areas not listed on the table do not have existing utility boilers.
**Zeros indicate that no additional reductions are achieved incremental to mandatory Act requirements.

TECHNICAL REPORT DATA

(Please read Instructions on reverse before completing)

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15. SUPPLEMENTARY NOTES
Work Assignment Manager - Carla Oldham

16. ABSTRACT

This document was prepared in response to section 184(b)(2) of the Clean Air Act which requires EPA to conduct a study to identify control measures capable of achieving emission reductions comparable to Stage II in the Northeast Ozone Transport Region (OTR). The report presents estimated emissions reductions associated with Stage II and a variety of stationary and mobile source control measures. Both VOC and NOx emissions reductions were evaluated. Results are given on an area-by-area basis for moderate, marginal, and incomplete data nonattainment areas, and attainment portions of the OTR States. Under the Clean Air Act, affected States have 1 year from completion of this study to adopt and submit to EPA as State implementation plan revision either Stage II or a comparable measure.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Stage II, gasoline vapor recovery, refueling emissions, comparable measure, Northeast Ozone Transport Region, ozone, volatile organic compounds, nitrogen oxides	Air Pollution control	

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